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THE UNIVERSITY OF ALBERTA

A COMPARATIVE EVALUATION OF SELECTED PHYSICAL EDUCATION PROGRAMS IN ELEMENTARY SCHOOLS

by

© PIERRE COTE

A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES
AND RESEARCH IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF SCIENCE

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THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled A Comparative Evaluation of Selected Physical Education Programs in Elementary Schools submitted by Pierre Côté in partial fulfillment of the requirements for the degree of Master of Science.

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Supervisor

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Jane Watkinson
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Date ....Jan 28/80........

ABSTRACT

The purpose of this study was to evaluate two programs of physical education at the elementary level on some determinants of physical fitness. The program of the experimental school included one hour of physical education daily, while there were two thirty-minute classes weekly in the control school. The sample studied was constituted of fifteen subjects of each sex in each of grade one, three and six. The activities in the two programs were the same. They included gymnastics, dance and games. The observation of the activity level of the classes showed that this was higher in the experimental groups than the control ones. A questionnaire was sent to the parents to evaluate the activity level outside the school. From the parents' answers the subjects were distributed in three groups of different levels. The comparison between the two extreme groups did not reveal any differences when physical working capacity (PWC_{170}/kg), skinfold thickness and flexibility were considered.

Each group of fifteen subjects was subdivided in thirds on the basis of the PWC_{170}/kg data collected in the fall. The comparison of the two programs using PWC_{170}/kg as the dependent variable showed significant differences when the lowest third of the groups was considered, and this was the case for each sex and all the groups under study. The experimental group improved over the school year while the control group remained at the same level. The analysis using skinfold thickness as the dependent variable showed differences between the two schools for the lowest PWC_{170}/kg portion. The grades were affected differently. No differences were recorded at grade three. In grade one, the boys and girls of the experimental group were significantly lower than the control at the end of the school year, being at the same level initially. For grade six, boys and girls, the skinfold thickness of the experimental group did not change over the school year, while it increased significantly in the case of the control group. No change was recorded for leg and back flexibility for the period investigated.

A difference between the two schools in growth velocity, for standing height and wrist circumference was recorded, indicating a faster growth for the control group. However this factor may be considered negligeable in regards to the results previously outlined, because the difference in growth velocity was recorded as being common to the three physical working capacity levels and the results using PWC_{170}/kg and skinfold thickness as dependent variables indicated differences with only one PWC_{170}/kg level, thus decreasing the probability of influence of this factor. It is concluded that the program of the experimental school improved some determinants of physical fitness. This positive influence was recorded in the children with a lower than average physical working capacity.

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CHAPTER I

INTRODUCTION

This study is concerned with the evaluation of the effects of daily physical education classes as compared with a regular program, as suscribed by the Alberta Ministry of Education, upon some anthropometric measurements and variable determinants of physical fitness (Bouchard et al., 1974). The specific determinants examined were the efficiency of the oxygen transport system, proportion of fat in body weight and flexibility related to accurate positioning of the pelvis.

The dependent variables evaluated in this study are also related to the general objectives of physical education. However, before this relationship can be explained, the general objectives of physical education must be outlined. The general objectives of physical education at the elementary level are highly related to the general aim of education, that is the promotion of the growth of the child in regard to all the dimensions of human capacities: cognitive, psychologic, motor, physiologic and anthropometric. Education is also oriented toward the retention of what is learned for its future usefulness. All these stated dimensions are interrelated in the development of the child and the evaluation of the influence of different educational programs on some of them is of greater importance than on others.

A variety of physical activity experiences is important for a balanced motor development of the child and for enabling him or her to discover his or her interests. These various experiences and discoveries undoubtedly influence the child's further participation in physical activity as an adolescent and as an adult. The evaluation of such an exposure on physiological parameters is also important because if the child is actively involved in the various activities of the program, the latter parameters will be influenced. Such a situation would have repercussions on the motor development of the child and a more complete experimentation of his or her interests would also reinforce his or her future involvement in physical activity. In addition, stimulated physiologic development could influence the child's anthropometric development. Cognitive and psychologic development is more dependent on the structure of the program and the teaching philosophy than on any other variables. From these considerations, the physical fitness state of the child can be seen as an important variable to investigate.

The concept of physical fitness was originally developed from health considerations and this is still well accepted. Recently, however, the concept has been expanded to include the functional needs of the individual, which may be represented by the term "quality of life" (Bouchard et al., 1974, p. 38; Comité d'Etude, 1974, p. 60). This latter concept does not directly relate fitness to health but rather suggests that fitness could influence health status. From these two aspects of the concepts of physical fitness, health and functional needs, physical fitness can be interpreted socially as a right of modern man (Comité d'Etude, 1974, p. 60).

These considerations have roused the politicians' interest. In a recent publication, Marc Lalonde (1974), the former Minister of National Health and Welfare, expressed his concern about the improvement of the health of the population and agreed with McKeown (1972) who concluded:

> Past improvement has been due mainly to modification of the behaviour and changes in the environment and it is the same influence that we must look particularly for further advance.

Basing his argument on a new Health Field Concept (Laframboise, 1973), Lalonde (1974) outlined the three major causes of death in Canada: human biology, environment, and lifestyle. In analyzing the possible actions to take to influence the population toward modifications, he recognized the importance of education, at all levels, and the need for further research

> to identify the links between the living habits, or lifestyle, of individuals, and the levels of both mental and physical health (p. 55),

as well as

> to find out how Canadians can be influenced to take more individual responsibility for the health of their mind and bodies, and for reducing the risks which they impose on themselves by neglecting important lifestyle health factors (p. 56).

One concern for research, Lalonde noted, involves lifestyle and its relationship to health. Lifestyle includes physical activity habits and physical fitness. The particular influence of the elements of someone's lifestyle is hard to isolate in an in vivo situation and its analysis leads to weaker evidence than would otherwise be the case in an in vitro situation. The conclusions of the analysis of physical fitness reflect this situation. However, according to the previously outlined concept of physical fitness, the assessment of a direct relationship between health and this element of the lifestyle is not a prerequisite in order to establish its importance.

The second concern for research is, in a first instance, related to education and awareness of each individual about his or her own status, his or her own life. In a second instance, it is related to the different risk factors that have been demonstrated by epidemiologic investigations to be associated with the frequency of coronary heart disease. Physical activity, performed on a continuous basis over a long period of time has been demonstrated to modify the state of several coronary risk factors (Altekruse et al., 1973; Bonano et al., 1974; Choquette et al., 1973; Cooper et al., 1976; Gyntelberg et al., 1977; Lampman et al., 1977; Lopez et al., 1974; Wood et al., 1976), thus supporting the importance of this element of the lifestyle. From these considerations, the early introduction of physical activity patterns in life can be seen as a major need. What is the best time to introduce and reinforce physical activity patterns, if it is not during the elementary school years, where the children have their first contact with the structured society?

An increased emphasis on physical education classes has interested educators for several years (Encausse, 1957). This interest has been heightened through investigations of the effects of exercise on different variables: physical and intellectual growth, psychological aspects, motor development and physical fitness studied in controlled situations. However, to be effective, exercise needs to meet time, intensity and frequency requirements. To meet these requirements and to promote an optimal time allotment to physical education, physical educators are putting forward arguments originating from investigations on the effects of exercise. A qualitative and quantitative evaluation of the physical education program regarding the different variables on which modifications are anticipated and of the effects of this program on the students is of primary importance to assess optimal time allotment.

CHAPTER II

REVIEW OF LITERATURE

The Evaluation of Daily Physical Education

Physical education classes at the elementary level roused a particular interest in the French medical corps as early as 1933 (Encausse, 1957, p. 5). The first experiment regarding daily physical education was undertaken at that time and later followed by others directed by Encausse (1957). The variables measured were anthropometric and academic in nature. No physiological variables were evaluated. No conclusions can be drawn from this series of experiments because of errors in their design. The control and experimental groups, when the two were present, were not comparable regarding environmental factors. The composition of the academic results between the two treatment groups was also weak because the students who were submitted to the terminal examination of the elementary level, the criteria for comparison, were selected by the classroom teachers. No statistical treatment was done on any of the measured variables.

Since that time little information has been published regarding the effects of physical education classes on physiological parameters related to physical fitness and even less concerning children at the elementary level.

Taddonio (1966) studied the effects of a daily period of calisthenics upon physical fitness of fifth-grade boys and girls, as evaluated by the AAHPER test battery. There was only one significant difference between control and experimental group at the post-test, the 50-yard dash for the boys.

Fabricus (1964) also studied the effects of added calisthenics but on grade four boys and girls. The only measured dependent variable was the performance of the Oregon Motor Fitness test. No data evaluating growth were collected. The results of each subject were expressed as the addition of the standard points for each test. Although significant difference between the control and experimental groups is reported for the post-test results, conclusions should be made cautiously. Growth is a factor that will influence the results of motor performance tests. The three tests for grade four girls are flexed arm hang, standing broad jump and crossed-arm curl-ups, and for boys they are standing broad jumps, push-ups and straight leg sit-ups. The use of two tests in this battery can be questioned. There seem to be duplication of measures for girls as the flexed arm hang and curl-ups are included. The flexed arm hang might not be as good an indicator of flexors strength or endurance because of the big motivational factor that can influence the result. The second test which might be criticized is the straight leg sit-up which presents definite danger for the lower back and does not measure abdominal strength or endurance. A composite score of such a test-battery also does not give a comprehensive picture of what is called physical fitness. According to Bouchard et al. (1974), the five variable determinants of physical fitness are the efficiency of the oxygen transport system, the proportion of fat in the body weight, muscular strength and endurance, posture and correct positioning of the pelvis, and the capacity of relaxation. The test-battery evaluates only one determinant of physical fitness, muscular strength and endurance. From this discussion it can be seen that conclusions about the effects of this particular program of calisthenics on muscular strength and endurance are unwarranted.

Bar-Or and Zwiren (1973) studied the effects of different time allotments and content of physical education classes over a period of nine weeks on three grade four classes. There were three weekly time allotments, two, three and four lessons. However the length of each lesson was not specified. There were two categories of content: the regular category with calisthenics and movement games, and the endurance category with strenuous interval training in each lesson. Each class was given a different time allotment and was further divided into two groups according to content. These two groups were matched for sex, maximum oxygen uptake and ethnic origin. The variables measured before and after the nine week period were maximal oxygen uptake, heart rate, and anthropometric and pulmonary variables. Among them only variations in submaximal heart rate during a treadmill test were found significantly different between the endurance and regular categories in boys. These findings corroborated those of Massicotte and MacNab (1974) on eleven to thirteen year old boys and of Stewart and Gutin (1976) on ten to twelve year old boys. These experiments were designed as training studies. Bar-Or and Zwiren (1973) reported no significant changes for the girls. They noted that the variation in submaximal heart rate was greater for the group having three lessons a week than for the other two groups. Based on the intensity of training which each class managed to carry out, the authors suggested

> that the children practicing four times a week became more fatigued than the others and this adversely affected their response to exercise (p. 515).

This conclusion must be discussed in view of two considerations. First, the conclusion about the differences in submaximal heart rate among the time allotments for the endurance group is not statistically verified and the use of this information as presented leads to questionable conclusions. A second consideration is that the frequent performance of very high intensity work requires high physical working capacity, which may not be true of these children.

The authors' finding, quoted above, may be related to this consideration. It also reinforces the idea that the quantity and intensity of the physical activity level must be adapted to the capacity of the individuals involved and their aims.

Martens (1976) undertook in June 1974 a longitudinal study of the effects of daily physical education classes on grades four to seven. The dependent variables studied are academic achievement and the CAHPER physical fitness test battery, including the evaluation of the physical working capacity for a heart rate of 170 (PWC_{170}). The special program of daily physical education began in September 1975. The data collected in June 1974 for the grades four to seven was considered the control information for further comparisons. Significant improvements of the means of PWC_{170}/kg for grades 5, 6, and 7 was found in 1975 when compared with 1974 data, while significant decrease is reported for grades 5 to 7 when 1976 data was compared with the information collected in 1974. Such unexpected results can be explained by cohort influence which creates differences between subjects of a given grade in June 1974 and those of the same grade in June 1976. The sex of the subjects involved in the study was also not specified in the report. For these reasons, no subsequent conclusions are warranted.

Kemper et al. (1976) evaluated the effects of increased time allotment in physical education on twelve and thirteen year old boys. They evaluated anthropometric development, PWC_{170}, percent body fat from skinfolds, flexibility with the sit and reach, and specific performance tests. They based their analysis on two interfering variables, skeletal age and habitual physical activity. They evaluated skeletal age from wrist X-rays according to standard methods and habitual physical activity from data collected with pedometers. The authors used covariance analysis in a series of hypotheses to isolate the experimental component physical education classes. Only handgrip strength revealed to be significantly influenced by the experimental condition. However the pedometer has been found an unreliable instrument (kemper et al., 1977; Saris et al., 1977) which invalidates the results of the analysis and does not warrant any valid conclusion.

Goode et al. (1976) investigated the influence of a special activity program on 12 to 14 year old boys and girls. They evaluated height, weight, PWC_{170}, body fat on the basis of skinfold measurements and predicted maximal oxygen uptake. They also presented results for the 12 minute run, and a 600 yard run. The special activity program was a daily period of 6 minutes during which the children were asked to perform generalized activities that would elicit a heart rate between 150 and 165 beats per minute. The program lasted four months and experimental (n = 305) and control (n = 301) groups were tested at the beginning (September-October) and at the end of the program. Each group had the same physical education schedule; four days in regular classes and a fifth one for health education. The regular physical education classes were 50 minute periods during which the students were active for 5 to 15 minutes, depending on the activity, for both control and experimental groups. The intensity level did not exceed 150 beats per minute during these classes except for the 6 minute period of the experimental group.

The results on height and weight showed some discrepancies for certain age groups when experimental and control groups were compared. However no statistical test was performed on these measurements. There was a difference in mean height increment greater than 2.0 cm for a 4 month period for 12 and 13 year old boys and 13 year old girls, always in favor of the experimental school which also had greater final means for these groups. There was a difference in the mean weight increment greater than 1.0 kg for the 13 year old boys favoring the experimental school and for the 14 year old boys favoring the control school. The size of each group of subjects, for each school, each age group and each sex was approximately 50. The extent to which physical growth can influence results of tests of a physiological nature on such a short period is not known. The different rates of growth for matched control and experimental groups can influence the results of the analysis.

The design of the analysis is not described. The test on which the probability statements are based is not stated. It seems that these statements apply only to differences in time (pre-test, post-test) so that no evaluation of the special physical activity program can be done. Also none of the information available supports the author's affirmation of a decrease in skinfold thinckness for the experimental group. Rather, it suggests no change. The authors began their discussion by stating that the special activity program

> was found adequate to improve cardiorespiratory endurance as measured by a test of Physical Working Capacity,...(p. 246).

When no statistical test to ascertain this fact is clearly presented and when different growth rates could influence the results of such an investigation, this affirmation can be challenged. The qualifying term "improve" must be used cautiously. A lack of stimulation may retard the growth and development process (Bailey, 1973, 1975), and if in applying a correction to this situation the negative effects are overcome, it is not an improvement but rather a return to a normal state.

Current trends in our country promote daily physical education classes, which is one of the conclusions of the recent national report on elementary physical education (Robbin et al., 1976). However this report fails to bring forward arguments of a physiological nature to sustain its recommendations. Comparative evaluation of the proposed changes on selected physiological variables is needed to enable educators to take appropriate decisions.

The Influence of Physical Activity on Physical Working Capacity and Body Composition

Modification of the physical activity pattern of children can cause significant physiological changes. Weber et al. (1976) reported positive training effects in prepubescent twins on maximal oxygen consumption. Ekblom (1969), Lussier et al. (1977), Massicotte et al. (1974), and Eriksson et al. (1973) found significant increase of the same parameter with training. The last three investigators and Stewart et al. (1976) found significant decrease of heart rate at sub-maximal work rates. Lussier et al. (1977) did not find any change in body composition of girls as a result of a running training program. However Parizkova (1968) found that lean body mass and body fat was significantly influenced by the physical activity level of young boys. She also reported in 1976 that lean body mass correlates well with height during the growth spurt period in adolescent boys (r = .89). When correlated with weight, lean body mass shows the same behaviour (r = 0.92) but body fat reveals a low degree of relationship (r = .51). The latter fact is interesting, suggesting a greater influence of extrinsic factors on body fat.

Another approach in the study of the effects of physical activity upon physical working capacity and body composition is to investigate the effects of habitual physical activity levels upon these two parameters. Bailey (1973) reported that for boys, studied longitudinally from eight to fifteen years old, aerobic power is greater for the more physically active children, as classified by their teachers. It was the same for isometric strength and suppleness as measured by the sit and reach test. Watson et al. (1976) studied the relationships between level of habitual physical activity, body composition, body size and physical working capacity of seventeen and eighteen year old boys. Habitual physical activity level was evaluated by means of a questionnaire and interview. They reported significant relationships between PWC_{170} and anthropometric measurements (r = .612), level of habitual physical activity (r = .587) and strength (r = .727) and between level of habitual physical activity and motor ability (r = .621). However they did not find any significant relationship between the proportion of fat in body weight and any of the other variables investigated. The body fat was predicted from skinfold thickness. The authors concluded that habitual physical activity had a significant influence upon all the dependent variables except percent body fat. However, as pointed out by Parizkova (1968) and Bailey (1973), it is not known if children are more physically active because they have high physical working capacity or if children have high physical working capacity because they are more physically active. This dilemma is not answered yet but it is known that the physical activity stimulus has to be high to cause important changes on physical working capacity and body composition (Massicotte et al., 1974; Parizkova, 1968).

The Evaluation of Physical Working Capacity

The validation of the estimation of the physical working capacity has been realized using two methods. Walhund (1948) devised a test to evaluate strictly submaximal working capacity. The importance of the submaximal capacity to produce work begins to assume more relevance as the concept of the so-called anaerobic threshold is developed (Wasserman et al., 1973; Whipp and Wasserman, 1972; MacDougall, 1977; Davis et al., 1976; Weltman et al., 1978) and finds practical relevance (Costill et al., 1973; Withers, 1977). Astrand and Rhyming (1954) and Astrand (1960) constructed a nomogram to predict maximal oxygen consumption, a parameter which reflects the ability to produce large amounts of energy for prolonged periods of time (Astrand & Astrand, 1978). These two methods for the evaluation of physical working capacity are based on the same principle; the direct relationship between heart rate and work load at submaximal work rates. The relationship between submaximal and maximal response to work is good, the correlation coefficient ranging between .63 and .92 (Astrand et al., 1954; Astrand, 1960; Dobeln et al., 1967; Glassford et al., 1965; Terelinna et al., 1966). Although the relationship is good, the prediction has a certain degree of inaccuracy. This fact is well documented in adults (Dobeln et al., 1967; Glassford et al., 1965; Hettinger et al., 1961; Kavanagh et al., 1976; Teralinna et al., 1966) and also in children (Cumming et al., 1963; Hermansen et al., 1971; Davies et al., 1972). As pointed out by Cumming et al. (1963), it is not desirable to introduce uncontrolled variability in the evaluation of physical working capacity, especially when using this information to compare different groups of individuals. On the basis of the Walhund's findings (1948) and the strength of the relationship with maximal oxygen consumption it is concluded that the evaluation of the submaximal working capacity as described by Howell and co-workers (1968) is a valid estimation of the efficiency of the oxygen transport system. The method referred to above has been found reliable in children by Zahar (1965).

The Evaluation of Body Composition from Skinfold Measurements

Two techniques are presently available to evaluate accurately body composition: underwater weighing and body potassium - 40 (K-40)counting. These methods require special equipment and facilities that make them impractical for field evaluation of body composition. The measure of adiposity using skinfold calipers has been developed for its practicality in the field.

Some investigators explored the relationship between the proportion of fat in the body weight (% body fat) estimated from laboratory methods and the measure of adiposity in children. Frobes et al. (1970) based their evaluation of percent body fat on K-40 counting and related it with the average of six skinfolds, and also separately for two sites, triceps and subscapula. With a very large original sample, the authors differentiated each sex and developed regression equations to predict fat weight for a very narrow age span of one year. This fact leads to predictive equations based on small samples (< 30 subjects), which present a significant loss of power in the predictability of the equation.

Lohman et al. (1975) also used K-40 counting to investigate the relationship of lean body mass and fat weight with skinfold thickness. They originally measured ten sites, but present formula using two sites, triceps and subscapular skinfolds, and body weight. They used a very large sample of boys between 6.3 and 12.9 years of age. They did not find age to be a significant predictor of lean body mass, even in subdividing the original sample into five age groups. This is an interesting fact suggesting that there is no need to divide prepubescent boys into different age groups to predict body composition. However the accuracy of the prediction of body fat was low, with a standard error of estimate of 1.73 kg. This fact does not strongly support the use of this formula. Test re-test reliability coefficients were presented but no cross-validation of the suggested formula was performed.

Parizkova et al (1972) studied boys and girls between eight and thirteen years of age. They based their investigation of the relationship of body fat and adiposity on hydrostatic weighing. As previously reported (Parizkova et al., 1961) the new regression equations to predict relative amount of fat from skinfold measurements did not significantly differ from boys and girls and equations including the two groups were also presented. Predictive equations of relative amount of fat based on two, five and eleven skinfolds were developed. The increase in the number of sites did not affect the precision of the prediction. A correlation of 0.857 and a standard error of estimate of 4.97% of body fat were obtained using two sites, triceps and biceps. The authors did not cross-validate their equations.

Cureton et al. (1975) compared densitometric, potassium-40, and skinfold estimates of body composition in prepubescent boys. The estimate based on skinfold measurements was found to be the least accurate. The underwater weighing was found to have a stronger relationship with percent body fat than K-40 counting. There was an important discrepancy when lean subjects (< 10% of body fat) were considered. For this class of subjects, the estimation of percent body fat from K-40 counting was consistently lower than both of the results obtained from underwater weighing or skinfold thickness. This fact is very important to consider when K-40 counting or equations validated by the means of this technique are used to evaluate changes. If a subject has an initial value greater than 10%, this change can be exaggerated, and this fact repeated on many subjects will bias the analysis of the results.

Flint et al. (1977) and Wilmore et al. (1970) evaluated the validity of previously developed formulae for the evaluation of body fat from skinfold and anthropometric measurements. They questioned the accuracy of the formulae and concluded that it was not valid to use the results of their prediction for research purposes.

In a factor analytical study of anthropometric variables for the assessment of body composition, Jackson et al. (1976) identified, among other factors, that skinfold measurements were the principal constituent of the factor body fat. On this basis it is not necessary to predict body to have an evaluation of this parameter using skinfold measurements. When testing differences between means to evaluate changes on the basis of skinfold measurements, the inaccuracy of the prediction is an important factor to consider and it can be avoided by the direct use of the results of the measurements, for example the sum of skinfolds.

CHAPTER III

THE DESIGN OF THE STUDY

Subjects

The subjects in this study were elementary school children, boys and girls in grades one, three and six from schools situated in the town of Spruce Grove, a suburb of Edmonton.

Each of these schools has taken a different approach toward education. The program in the experimental school, Millgrove, is distinct from the control school as more time (one hour a day each) is set aside for physical education, fine arts and creative language arts. The physical education classes are taught in the majority of cases by the homeroom teachers. Two physical education specialists are staff members and act as consultants to the other teachers. The control school, Brookwood, has a regular program which involves two thirty minute periods of physical education every week. All the physical education classes are taught by the same teacher, a physical education specialist.

A description of the housing situation of the sample is presented in Table 1. A larger number of subjects in the experimental school lived outside of the urban agglomeration. The age of the sampled subjects as of the first of October 1977 is presented in Table 2. The variations are small and warrant further comparison.

Methods and Procedure

In the fall of 1977, random samples of fifteen subjects plus alternates from each grade and of each sex were selected from class lists in the two schools. Prior to the testing, forms were sent to the parents of the subjects and alternates to inform them of our activities and to obtain their consent.

Four different variables were measured. First, the efficiency of the oxygen transport system was evaluated by means of a submaximal test. This bicycle ergometer test was performed according to Howell and co-workers (1968) and evaluates the physical working capacity at a heart rate of 170. The heart rate was monitored by timing thirty beats with a stethoscope and stopwatch beginning at the last twenty seconds of each minute. The pedal revolutions of the bicycle were also recorded at the end of each minute. The ergometers were calibrated using known weights before testing at each school. Second, an evaluation of the proportion of fat in relation to body weight was made. Six skinfolds were measured according to the technique outlined by Bailey (1968). The location of these skinfolds measured with a Harpenden caliper was as follows: mid-triceps, mid-biceps, subscapular, subcostal in mid-clavicular line, abdominal immediately beside the umbilicus and iliac crest. All skinfold measurements were taken on the right side of the body. One measurement was taken at each site and then the process was repeated. The replicates for each site were then averaged if the difference between them was not greater than four millimeters. If necessary, a third measurement was taken and the closer two meeting the previous criteria were averaged. The third variable was a measure of flexibility. It was estimated by means of the sit-and-reach test, performed according to Jetté (1977). The last variable was designed to monitor growth. It was composed of four anthropometric measurements: wrist and upper arm girth recorded with a Lufkin tape to the nearest millimeter, body weight measured with a carefully calibrated and levelled spring scale manufactured by Decca, and recorded to the nearest two-tenth of a kilogram, and finally standing height recorded to the nearest millimeter with a triangle and a measuring tape placed on a wall. These measurements were performed according to the technique outlined by Bailey (1968). The upper-arm girth was transformed according to Frisancho (1974) into corrected upper-arm diameter.

An attempt was made to quantitatively and qualitatively assess the differences in the two programs of physical education through analysis of the intensity and duration of the different activities of the physical education classes.

The activities included in the program were similar in the two schools. Both programs were based on gymnastics, dance and games. Beginning [illegible] February, the duration and intensity of children's activities were evaluated by observations of selected classes. The time for each activity in the class was measured and each was classified according to four intensity levels: no activity, activity producing a heart rate below 129, from 130 to 150, and over 150. All the observations were made by the same observer. The validation of the classification process was made during two sessions that involved a total of fifteen heart rate measurements on children between five and seven years of age and a previously assessed intensity level. The validation procedure considered only a single individual at a time. The classification of the intensity level during the observed physical education classes was assessed in regard to the average activity level in the class. The reliability of the classification process was verified on a continuous basis from observations of grade two, four and five classes. The class average activity level was classified and this classification was subsequently verified on one or two children by monitoring their heart rate over a period of ten seconds using the palpation technique.

A written questionnaire (Appendix I) to be completed by the parents was distributed to all the children involved in the study prior to the re-test period. The purpose of this questionnaire was to evaluate habitual physical activity level to enable the investigation of the importance of this parameter upon the variable determinants of physical fitness under study. Multiple choice questions regarding general activities outside school hours and a listing of sport and recreational activities constituted the two parts of the questionnaire. The return rate was 86%, which we considered good. Three elements were taken into account in the classification of each sex and grade in high, medium and low habitual physical activity levels. The first element is the intensity at which a given activity is generally performed. The list was divided into three levels: high, medium and low, and more importance was given to the activities of higher intensity level in the classification. The second and third elements were based on time of involvement in these activities, their time allotment during the week and their yearly importance. Each sex and age group was independently classified in three categories by two raters and the few discrepancies between the two classifications were discussed and one was finalized.

The investigation of the influence of habitual physsical activity as evaluated by the questionnaire upon some variable determinants of physical fitness was performed on only one school, the control school, on which this factor would have a greater importance.

Statistical Design

The design of the investigation of the effects of habitual physical activity level was a 3 x 2 x 2 factorial design, using grade, sex, and habitual physical activity respectively as independent variables. A five-way analysis of variance with repeated measures was performed to test differences between the two schools for the pre-test and post-test data. The independent variables were treatment group, sex, grade, initial PWC_{170}/kg level and the two repeated measures, a 2 x 2 x 3 x 3 x 2 factorial design. Interactions of higher order than a two-way were interpreted according to the technique described by Keppel (1973). The post-hoc analysis, when appropriate, was based on the Tukey multiple-comparison method, unless otherwise specified. The accepted level of significance was a probability greater than 95%. The analysis was performed using the statistical package for the social sciences (SPSS) as implemented under the MTS system (Precht, 1977).

The independent variable labelled initial PWC_{170}/kg level was obtained by subdividing each group of subjects of the same school, grade and sex into three subgroups according to the results of the initial test of physical working capacity.

CHAPTER IV

RESULTS

The Physical Activity Level During Physical Education Classes

The results of the observation of the activity level of some of the classes are summarized in Table 3. The number of classes on which the data was based is low, however no classes were observed twice. The number of observations is smaller in the case of the control school because the same teacher was giving all of the physical education classes and thus more continuity was expected. Another reason for this is that no observation was recorded in the month of May because the teacher was collecting data from the classes for the Canadian fitness award. During these classes, the average physical activity was not greater than level one for the average of the group. Of the two grades for which there is complete data, the experimental school showed greater total time spent in an activity situation. Activities that result in a level of exertion sufficient to induce adaptation to work, classified as two and three, seemed to be performed for longer periods of time in the experimental school, as indicated by the data.

The Evaluation of Habitual Physical Activity

The results of the analyses of variance on PWC_{170}/kg, the sum of six skinfolds and lower back and leg flexibility are presented in Tables 4 to 9. Remarkably, the comparison between the high and low habitual physical activity classifications did not produce any trend which would have resulted in the rejection of the null hypothesis. Only one significant interaction involving habitual activity level as an independent variable was found, that being the interaction between sex and habitual activity level for the sum of six skinfolds. No significant differences, using the Tukey test, were found when comparing the high and low group for each sex (Table 10).

Height

Three important interactions were present in the analysis of variance using height as the dependent variable (Table 11). For the interaction between sex and grade, no significant differences among the means were found (Table 12). The grade main effect depicted the cross-sectional growth in height (Table 13). The second interaction involved the longitudinal aspect of the study. The analysis of the simple interaction effects between sex and time for the three grades under investigation showed one interaction at grade six (Table 14). Tests on these means revealed a faster rate of growth for girls when compared to boys (Table 15). The third interaction was detected between the treatment groups for the experimental period. The control group was found to have a faster rate of growth when compared to the experimental group (Table 16). In this case the F ratio was equal to 9.04.

Wrist Circumference

In the analysis of variance involving the non-repeated factors, three main effects were significant (Table 18). The sex main effect indicated a bigger structure for boys (Table 19). The grade and time main effects showed, on a cross-sectional basis and a longitudinal basis respectively an increase in size with age (Tables 20 and 21). Although an initial PWC_{170}/kg level main effect was present, no significant difference between the means of the three levels was found (Table 22). Two interactions including time as an independent variable were shown. The grade six had a faster growth rate than either grade one or three (Table 23). As well, the control group was growing at a faster rate than the experimental group (Table 24). In the latter case the Q value for the second hypothesis was equal to 4.30.

Body Weight

Two interactions were found in the analysis of variance using body weight as the dependent variable (Table 25). In the sex and grade interaction, no significant differences were present between the sexes at each grade

(Table 26). The two sexes behaved according to the grade main effect (Table 27). No significant difference between the means of the initial PWC_{170}/kg level main effect were found (Table 28), although this main effect was detected as significant. The second interaction involved grade and time. The body weight was found to increase only in grades three and six with the latter increase being the larger (Table 29). There was an increase in body weight over the period under study as indicated by the time main effect (Table 30). This increase was the same for both sexes, no interaction involving the two independent variables sex and time being detected, but was found only in grades three and six as indicated by the grade and time interaction.

Corrected Upper-Arm Diameter

The portion of the analysis of variance without the repeated measurement factor using corrected upper-arm diameter as the dependent variable presented two main effects (Table 31). The sex main effect showed larger diameters for boys (Table 32). Increase in diameter was also related to age when studied cross-sectionally (Table 33). Two interactions with the repeated measurement factor were significant. The rate of growth was found to be faster for grade six than grade three while it was the same for grades one and three (Table 34). The rate of increase was also found to be different when the subjects were divided according to the initial PWC_{170}/kg level. The medium and low levels were found to increase significantly more than the high level during the period under investigation (Table 35). The time main effect indicated an increase in corrected upper arm diameter for the seven month period (Table 36). This change took place in the three grades in both sexes, in the three physical working capacity levels, and in both two treatment groups.

Physical Working Capacity

There were many important interactions in the analysis of variance using PWC_{170}/kg of body weight as the dependent variable (Table 37). Although significance was shown for the interaction between treatment group and sex, no difference between control and experimental group was found (Table 38). The sex main effect indicated a higher physical working capacity in boys for the two treatment groups (Table 39). When compared cross-sectionally, the sexes were found to behave differently. The simple interaction effects of the interaction among sex, grade and time showed two interactions between sex and time at grades three and six (Table 41). The boys in grade three were found to improve while the girls did not (Table 42); the opposite took place at grade six (Table 43). Different tendencies were however found when comparing the results according to grades only (Table 40). The boys improved from grades three to six while the girls decreased when considering the same grades. The initial PWC_{170}/kg level main effect showed that the classification was sound (Table 44). The interaction among treatment group, initial PWC_{170}/kg level and time was divided into three simple interaction effects according to the initial levels (Table 45). Only the interaction involving the low level was significant. The experimental group was at a lower level than the control group initially and at a higher level at the end of the school year. No significant change was detected for the control group over the period under study (Table 46). The time main effect showed an overall significant increase in physical working capacity when expressed relatively to body weight (Table 47). This increase was found to be dependent on sex and grades (Table 41), and treatment group depending on the physical working capacity level (Table 46).

The Sum of Skinfolds

Only one interaction was detected in the analysis of variance involving the non-repeated factors, using the sum of skinfolds as the dependent variable (Table 48). However the tests on the means of this interaction, the treatment group and sex interaction, did not reveal any significant differences (Table 49). Three main effects were present. The sex main effect (Table 48) showed no significant differences between the two groups (Table 50). The grade main effect showed significant differences only between the two extremes (Table 51). The initial PWC_{170}/kg level main effect showed that the low group had greater skinfold thickness than the medium and high groups which were not found to be different with regard to this variable (Table 52). When the analysis with the repeated factor was considered, a high-order interaction was present among the treatment group, grade, initial PWC_{170}/kg level and time. It was found from the analysis of the simple interaction effects (Table 53), that two PWC_{170}/kg levels showed significant interactions. The further division of the data of these two levels into lower-order simple interaction effects revealed that there was no interaction within each grade for the high level and that there were two within grade interactions between treatment group and time, at grades one and six. The tests of the means of the simple interaction effect of the low level of grade one showed a decrease in skinfold thickness for the experimental group when compared to the control which did not change over the period of investigation (Table 54). The decrement of the experimental group missed statistical significance by less than .006 for the Q value. The tests of the means of the simple interaction effect of the low level of grade six showed an initial difference between the control and experimental groups, the control group having smaller skinfold thickness (Table 55). At the end of the school year, the positions were reversed, the control group having larger skinfolds while those of the experimental group remained constant. Although the time main effect was significant, no difference was found between the pre-test and post-test data (Table 56). It is only over different grades, physical working capacity levels and treatment groups that the seven month period of the study showed an influence upon skinfold thickness.

Flexibility

Neither the main effect of the repeated measurement dimension nor any interaction including this dimension were significant using leg and back flexibility as the dependent variable (Table 57). The analysis of variance without the repeated measurement factor presented three significant main effects. The treatment group main effect showed differences between the experimental and control groups, indicating a better flexibility for the experimental group (Table 58). The sex main effect indicated a superior flexibility for girls than for boys (Table 59). No significant differences between grades were found although the main effect was reported as such (Table 60).

CHAPTER V

DISCUSSION

The Physical Activity Level of the Physical Education Classes

The evaluation of the physical activity level of the physical education classes was not performed systematically. This fact prevented generalizations being drawn from this information. However the data collected would tend to suggest that the activity levels sufficient to induce physical adaptation were performed for longer periods of time in the experimental school. The activity level is the factor to consider in lesson planning if some effects upon physical fitness are desired.

The Habitual Physical Activity Level

The habitual physical activity level is another factor which influences physical fitness. However, the physical activity stimulus has a threshold beyond which adaptation occurs (Parizkova, 1968; Stewart et al., 1976; Massicotte et al., 1974). When habitual physical activity is evaluated, this threshold must be considered. Such an evaluation requires information about intensity and duration of the activities performed as well as their relative weekly and monthly importance. The purpose of the questionnaire was to evaluate the extent to which the children sampled were involved in physical activity in general and particularly their involvement in sport activities, by means of questions of a general nature. To be a worthwhile variable to include in the analysis of different physical education programs, the influence of habitual physical activity would have to be detectable over a large number of subjects, which is the reason for the inclusion of at least four subjects in the high and low groups.

There can be two reasons presented to explain why the questionnaire evaluation failed to detect any relationship between the classification and the variable determinants of physical fitness under investigation. The first reason could be the low number of subjects in the high classification involved in regular activities that are likely to induce adaptation to work. The second reason could be the lack of reliability of the response. If the questionnaire was not filled in conscientiously and not all information was provided by the respondent, underclassification would result which could therefore bias the investigation.

Since the question pertaining to the relationships between high physical working capacity and the degree of involvement in physical activity has not as yet been answered in the literature (Parizkova, 1967; Bailey, 1973), it was decided to introduce the initial physical working capacity level as an independent variable in the comparative analysis of the two physical education programs.

Height

The means for height of different studies from different countries are compared in Table 61 (for boys) and Table 62 (for girls). For both sexes, the means in this study were found to be slightly higher than in the reference studies. It is important to note that comparison was made between data collected in different populations. Three of these studies originated from Scandinavian countries (Backstrom et al., 1971; Brundtland et al., 1975, and Karlberg et al., 1976) while the other one was from the United States (McCammon, 1970). The differences between the reference studies and the data of this investigation increased a little more at age eleven for both sexes.

It was found that height was increasing with grade, which was the result of growth (Table 13). The rate of growth was found to differ only between grade six boys and girls, favoring the girls. This difference is easily explained by the earlier onset of the growth spurt in the girls (McCammon, 1970)(Tables 14, 15). The two treatment groups were found to have different rates of growth for height, the control group being faster (Table 16). This situation is common to all grades, all physical working capacity levels and both sexes as no interaction including these three independent variables was present.

Wrist Circumference

Wrist circumference is a measure that complements height in evaluating body structure because of its relationship to sex (Table 19). The same results obtained with height were found in the analysis of variance using wrist circumference as the dependent variable. Growth in size was found in the comparison between grades and also between the two measurements (Tables 20, 21). The grade six subjects were found to have a faster rate of growth, but this situation was the same for both sexes while only the girls were showing a faster rate of growth for height (Tables 10, 11, 23). The presence of an interaction between treatment groups and time for wrist circumference corroborated the results of the analysis using height as the dependent variable (Table 24). It will be of importance further in the discussion to note that this difference in rate was present across sex, grade and initial PWC_{170}/kg level as no other interaction involving treatment groups, time and one of these independent variables was detected in the analysis using height and wrist circumference as dependent variables.

Body Weight

The means for body weight of different studies are presented in Tables 63 (for boys) and 64 (for girls). The boys in the present study fell well within the range of the values reported. It is interesting to note that although they were found taller at eleven years old, their mean body weight was close to the data from the other studies. The data for girls present a slightly different picture as they were found appreciably heavier at eleven years old in comparison with the other studies, while being comparatively of the same weight at six and ~~eight years~~ old. This could be explained by an earlier onset of puberty in the sample involved in this study, as indicated by the data for height.

When body weight was used as the dependent variable in the comparative analysis, it was found that the increase over the period under study was seen in grades three and six only, the grade six increasing faster than the grade three (Table 29). The treatment groups and both sexes behaved in the same manner; no interaction, including these independent variables, was reported for the investigated period.

Corrected Upper-Arm Diameter

The mean values obtained for the corrected upper-arm diameter in this study were compared with normative data collected in the Ten-State Survey in the United States (Frisancho, 1974) (Table 65). This comparison indicated a smaller muscular development of the subjects involved in this study in contrast to American standards. There can be several possible explanations, such as differences due to genetic background or physical activity level. The differences between the means seemed to decrease with the onset of puberty as the data provided by this study moved up in the normative distribution but still stayed appreciably lower than the average.

The findings of the analysis of variance regarding sex and age differences were corroborated by the normative data previously presented. Girls had a lower muscular development index except at eleven years of age. Then they joined the boys' level in the case of the normative data, but not in the case of this study where the girls were smaller than the boys. When the data collected in this investigation was analyzed longitudinally, grade six boys and girls were found to have a faster rate of muscular development than both grades one and three (Table 34). The other reported interaction based on the repeated measurement factor indicated a faster developmental rate for the medium and low physical working capacity level when compared to the high level (Table 35). The main effect of the initial physical working capacity level was not significant, indicating that all levels were at a similar stage of development. No influence of the age factor was present, as no interaction including physical working capacity level and time with grade was detected. Differential growth rates between physical working capacity levels using height, wrist circumference and body weight as dependent variables were not found in the analysis. Growth is not the factor that can explain the interaction between physical working capacity level and time for corrected upper-arm diameter. The treatment group factor did not affect corrected upper-arm diameter as neither interaction nor main effect including this factor were significant. However other factors such as physical working capacity and adiposity were influenced over the period under investigation by the treatment factor. This influence that was also detected differently across the physical working capacity levels. Physical activity does not seem to be a factor that would also explain the interaction between physical working capacity level and time for corrected upper-arm diameter. No reason is suggested to explain the presence of this interaction in this investigation.

The common denominator of all the findings related to the body dimensions is the faster rate of growth of the grade six subjects. In the case of height, the difference in growth rate was found between boys and girls, while all the other variables showed the occurrence of this phenomenon for both sexes. Growth is the factor that has the greatest influence on the child. It is uncontrollable and investigators can only account for it.

Physical Working Capacity

The results on PWC_{170}/kg obtained in this study are compared with Canadian norms and some data collected last year in the Edmonton school boards in Tables 66 and 67. The data of this study collected in the fall are close to the mean of the norms for eight year old boys and eleven year old girls. The eight year old girls and eleven year old boys showed higher physical working capacity than the norms. For both sexes and at all age groups the data collected in the spring is higher than both the norms and the Edmonton investigation.

The analysis of variance demonstrated that cross-sectional and longitudinal data do not provide information of the same nature. In the cross-sectional investigation, a sex interaction showed that the physical working capacity of the grade one and three boys and girls decreased in capacity (Table 40). The repeated measurements showed that the grade three boys improved over the seven month period of the study while the girls were staying at the same level (Table 42). In grade six, the girls were improving while the boys were stationary (Table 43). The behaviour of the grade six subjects in the cross-sectional study is corroborated by the Canadian survey of 1968 (Howell et al., 1968). However, to interpret the trends found in the longitudinal aspect of this investigation properly, information of this nature collected over a longer period of time is required. This information would also provide data that would better explain the cross-sectional findings.

The comparison between the two schools using physical working capacity as the dependent variable showed that only the low PWC_{170}/kg level was influenced by the difference in programs (Table 45). The experimental group was found to improve while the control stayed stationary (Table 46). This influence was found in both sexes of all grades as no interaction including these two independent variables along with treatment group, initial PWC_{170}/kg level or time was detected. The other physical working capacity levels were not affected by the treatment factor over the period under investigation. The difference in growth rate between the two treatment groups reported earlier cannot explain the differences found for the low physical working capacity level using PWC_{170}/kg as the dependent variable because the differential developmental rate was found to be common to the PWC_{170}/kg levels. If the growth factor have had a determining influence on the results of the physical working capacity evaluation, it would have been detected for the three physical working capacity levels and not only one as it was the case. The factor responsible for the differences reported by the interaction between treatment group, initial physical working capacity level and time are attributable to the difference in program between the two schools.

The Sum of Six Skinfolds

A comparison between the means of two studies for the average of six skinfolds is shown in Table 68. The results of this study are found to be lower in all cases. Many factors could explain this situation. The origin of the two samples considered come from different populations, as Forbes et al (1970) were using children from the Rochester area. Population differences include biological differences as well as sociological differences such as physical activity and nutritional habits. A second factor that could influence the absolute value of skinfold measuremetns is the inter-tester variability.

The analysis of variance using the sum of skinfolds as the dependent variable showed no significant differences between sexes (Table 50). The cross-sectional aspect of the investigation revealed only increased sums between the two extreme age groups, grades one and six. This finding is in accordance with data reported by Forbes et al. (1972), Lohman et al. (1975), and Cureton et al. (1975) who showed that higher values are obtained between ten and twelve years of age. The classification of the subjects into physical working capacity levels found partial relevance using skinfold thickness as the dependent variable. A net distinction was made between the low level and the medium and high levels (Table 52). However no discrimination was found between the latter two. The comparison of the two treatment groups over the period under study according to grade and initial physical working capacity level lead to a very interesting finding. Only the low physical working capacity group was affected by the difference in program, and for only two of the three grades investigated (Tables 53, 54). These two grades were also affected differently. For grade one, the control group did not change and the experimental one decreased, but this decrement was just below the significance level. However there was a significant difference between the experimental and control groups at the post-test indicating a lower sum for the former, while the two groups were initially considered equal. For grade six the experimental group did not change and the control group increased in skinfold thickness. As previously noted in cross-sectional studies, and also in longitudinal study (Karlberg et al., 1976), skinfold thickness shows a rapid increase during the ten to twelve year old period. This fact depicts well the situation in the control school at grade six. The effect of physical activity, it would appear, was to prevent this increase from taking place in the experimental group. It must be noted that a potential factor in the interaction was the difference in growth velocity and the influence of this factor on adiposity (Tanner, 1970). In grades one and three, the average of six skinfolds in this study was found low in absolute value and when compared with other date (Forbes et al., 1970). In such a situation, a more important stimulus is required to create changes. This latter fact explains the presence of the discrepancy found between grades one and three. The observation of the activity level of the physical education classes (Table 3) showed that a higher activity level was found for grade one when compared to grade three for the experimental school. In average grade one spent twice as much time in the second classification and three times more time in the third one. The previously reported differential growth rate between the experimental and control group does not explain the differences found at grades one and six. Growth was occurring in the two groups, therefore changes caused by this factor were expected to happen in both of them. The earlier growth spurt of the girls was detected in both treatment groups as no interaction with this factor and the three others, grade, sex and the repeated measurements, was significant. The difference in the rate of growth was independent of the grade and initial physical working capacity level factors. If the rate of development had any influence upon the results of the analysis, using skinfold thickness as the dependent variable, it would not have happened for only two grades at only one physical working capacity level. This daily physical education program had a positive influence on adiposity. When classified according to their initial physical working capacity level, the subjects in the lowest group were found to have a large sum of skinfolds (Table 52). It is therefore important to decrease the sums of skinfolds of this group. The activity level was shown to be a critical factor as no influence of the increase in physical activity was detected in grade three, but was shown possible in grade one with a good activity level.

Flexibility

The important finding in the analysis of variance using leg and back flexibility as the dependent variable was the difference between the treatment groups. The experimental group was found higher than the control, and stayed the same over the period under study. However the absence of variation in time in both groups for this measure prevents one from making any assertion concerning the influence of the different physical education programs.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The results of the comparison between two selected physical education programs were that a daily physical education period improved significantly the physical working capacity of the children with an initially low physical working capacity. The adiposity of the same group of subjects was affected in only two grades. Leg and lower back flexibility was not affected by the difference in programs. It is of importance to note that only the low physical working capacity group was affected, which represents only one-third of the school population. This situation stresses the need to plan activities in which each child can reach and maintain for a total of a few minutes the intensity level which is above his or her own threshold if adaptation to physical work is desired. This may require the creation of situations in which the child is motivated to participate actively. It is when this objective is fulfilled that the physiological and psychological effects can be integrated. A true experience of physical activity must leave some physiological effects. If, in a group situation, more than the majority is positively affected, then situations in which motivation toward active participation have been created. Physical fitness is one of many objectives of physical education classes. It may be seen as a junction parameter in the evaluation of the effects of physical education classes but it represents only a part of what should constitute the goals of a physical education program.

The comparison of the two particular programs concerned by this study lead to the following conclusions:

- improved physical working capacity (PWC_{170}/kg) of the subjects with an initially low PWC_{170}/kg level in all grades in the school with daily physical education;
- decreased proportion of fat in body weight of the subjects with an initially low PWC_{170}/kg level in grades one and six in the school with daily physical education;
- did not influence leg and lower back flexibility.

The physical activity level in the classes is the factor explaining these partial results.

Recommendations

The on-going evaluation of the beneficial effects of daily physical education is needed. It is important to see if more complete changes will occur over time.

It would be valuable to investigate thoroughly the relative importance of daily physical education periods in the total daily activity of the child both quantatively and qualitatively. Such information would provide the explanation of the results obtained in this study. It would also provide data that could shed some light on the relationship between habitual physical activity and physical working capacity.

In future studies consideration should be given to identifying appropriate activities for different age groups in habitual physical activity questionnaires.

TABLES

Table 1. Description of the subjects according to the type of housing for each grade and school.

	Non-Bussed Students		Bussed Students		
	Houses	Apartments	Mobile Homes	Acreages	Farms
Grade 1 Control n = 28	27			1	
Grade 1 Experi. n = 30	16		3	11	
Grade 3 Control n = 29	27			2	
Grade 3 Experi. n = 28	14		3	8	3
Grade 6 Control n = 25	21	2		2	
Grade 6 Experi. n = 28	11		1	11	5

Table 2. Means and standard deviations for chronological age, in months, for each grade, sex and school.

		Boys			Girls		
		Grade 1	Grade 3	Grade 6	Grade 1	Grade 3	Grade 6
Experimental School	$\bar{X}$	76.1	100.6	133.5	74.1	99.8	138.7
	SD	5.9	6.3	10.7	5.0	4.9	6.8
	n	15	15	13	15	13	15
Control School	$\bar{X}$	74.9	98.5	138.3	72.1	99.2	135.3
	SD	5.3	3.8	9.6	3.8	3.9	5.3
	n	15	14	15	14	15	10

Table 3. Total time, in minutes, spent at different activity levels during the observed classes.

		Experimental school				Control school			
Grade	Activity level	Nu of class	$\bar{x}$	min	max	Nu of class	$\bar{x}$	min	max
1	0	3	4.2	2.5	6.0	3	7.7	7.3	8.2
	1		15.3	9.0	25.3		10.7	9.5	11.5
	2		8.8	4.5	16.8		3.1	2.5	3.5
	3		2.0	0.0	6.0		1.0	0.0	2.2
3	0	5	11.3	8.16	14.7	2	4.3	4.1	5.2
	1		16.2	8.0	27.0		5.1	5.0	5.2
	2		4.5	1.0	10.0		1.0	0.6	1.3
	3		0.6	0.0	2.0		0.0		
6	0	3	11.4	5.0	14.7	0			
	1		22.7	20.7	24.0				
	2		1.6	0.0	4.7				
	3		0.3	0.0	1.0				

Table 4. Summary table of the analysis of variance pertaining to the investigation of habitual physical activity level using PWC_{170}/kg as the dependent variable.

(A = grade, B = sex, C = habitual activity level)

Source	Degrees of Freedom	Mean Squares	F Ratio	Probability
A	2.	1.903	0.328	0.722
B	1.	111.881	19.307	0.001
AB	2.	3.476	0.600	0.554
C	1.	0.206	0.036	0.851
AC	2.	9.656	1.666	0.202
BC	1.	5.279	0.911	0.346
ABC	2.	9.627	1.661	0.203
S-Within	38.	5.795		

Table 5. Means and standard deviations for each grade and sex when classified as high or low habitual physical activity level.

A	B	C	Mean	Std. Dev.	n
1	1	1	15.210	2.181	4
1	1	2	13.453	1.374	4
1	2	1	12.294	3.914	4
1	2	2	10.482	4.428	4
2	1	1	14.731	1.323	4
2	1	2	14.441	1.736	4
2	2	1	12.153	1.785	5
2	2	2	12.787	1.747	5
3	1	1	13.259	3.205	4
3	1	2	16.875	2.515	4
3	2	1	11.703	0.872	4
3	2	2	10.538	1.189	4

A = grade

1: grade 1   2: grade 3   3: grade 6

B = sex

1: boys   2: girls

C = habitual physical activity level

1: low   2: high

Table 6. Summary table of the analysis of variances pertaining to the investigation of habitual physical activity level using the sum of six skinfolds as the dependent variable.

(A = grade, B = sex, C = habitual activity level)

Source	Degrees of Freedom	Mean Squares	F Ratio	Probability
A	2.	4067.836	7.474	0.002
B	1.	204.698	0.376	0.543
AB	2.	96.239	0.177	0.839
C	1.	126.514	0.232	0.632
AC	2.	52.815	0.097	0.908
BC	1.	2349.552	4.317	0.045
ABC	2.	1743.879	3.204	0.052
S-Within	38.	544.251		

Table 7. Means and standard deviations for each grade and sex when classified as high or low habitual physical activity level.

A	B	C	Mean	Std. Dev.	n
1	1	1	41.375	26.644	4
1	1	2	41.075	13.147	4
1	2	1	40.125	9.276	4
1	2	2	41.025	6.346	4
2	1	1	41.575	17.249	4
2	1	2	31.475	1.936	4
2	2	1	42.160	15.402	5
2	2	2	38.580	13.780	5
3	1	1	82.475	52.183	4
3	1	2	42.025	13.199	4
3	2	1	54.050	8.592	4
3	2	2	88.425	45.200	4

A = grade

1: grade 1   2: grade 3   3: grade 6

B = sex

1: boys   2: girls

C = habitual physical activity level

1: low   2: high

Table 8. Summary table of the analysis of variance pertaining to the investigation of habitual physical activity level using leg and back flexibility, measured by the sit and reach, as the dependent variable.

(A = grade, B = sex, C = habitual activity level)

Source	Degrees of Freedom	Mean Squares	F Ratio	Probability
A	2.	13.893	0.296	0.745
B	1.	122.198	2.604	0.115
AB	2.	1.713	0.037	0.964
C	1.	13.270	0.283	0.598
AC	2.	115.967	2.472	0.098
BC	1.	0.582	0.012	0.912
ABC	2.	65.455	1.395	0.260
S-Within	38.	46.921		

Table 9. Means and standard deviations for each grade and sex when classified as high or low habitual physical activity level.

A	B	C	Mean	Std. Dev.	n
1	1	1	28.225	3.047	4
1	1	2	26.325	7.424	4
1	2	1	32.575	4.926	4
1	2	2	27.175	2.220	4
2	1	1	22.000	6.334	4
2	1	2	31.975	3.598	4
2	2	1	28.160	8.682	5
2	2	2	31.740	8.388	5
3	1	1	27.175	5.780	4
3	1	2	22.850	7.063	4
3	2	1	26.725	8.303	4
3	2	2	31.000	10.057	4

A = grade
1: grade 1   2: grade 3   3: grade 6

B = sex
1: boys   2: girls

C = habitual physical activity level
1: low   2: high

Table 10. Tests on the means of the interaction between sex and habitual activity level for the sum of six skinfolds (mm).

	Boys (B)	Girls (G)
High (H)	38.19	54.67
n	12	13
Low (L)	55.14	45.19
n	12	13
		p
	H1: BH < BL	N.S.
	G2: GL < GH	N.S.

N.S. p > .05

Table 11. Summary table of the analysis of variance using height as the dependent variable.

(A = Treatment group, B = Sex, C = Grade, D = Initial PWC_{170}/kg level, E = Time)

Source	Degrees of Freedom	Mean Squares	F Ratio	Probability
A	1.	22.785	0.307	0.581
B	1.	27.342	0.368	0.545
AB	1.	59.241	0.798	0.373
C	2.	27904.574	375.781	0.001
AC	2.	22.785	0.307	0.736
BC	2.	273.418	3.682	0.028
ABC	2.	77.468	1.043	0.355
D	2.	45.570	0.614	0.543
AD	2.	259.747	3.498	0.033
BD	2.	43.291	0.583	0.560
ABD	2.	54.684	0.736	0.481
CD	4.	134.430	1.810	0.131
ACD	4.	306.456	4.127	0.003
BCD	4.	48.987	0.660	0.621
ABCD	4.	61.519	0.828	0.509
S-Within	132.	74.258		
E	1.	1002.532	278.598	0.001
AE	1.	22.785	6.332	0.013
BE		0.0	0.0	0.999
ABE	1.	4.557	1.266	0.262
CE	2.	2.278	0.633	0.533
ACE	2.	9.114	2.533	0.083
BCE	2.	15.949	4.432	0.014
ABCE	2.	0.0	0.0	0.999
DE	2.	9.114	2.533	0.083
ADE	2.	2.278	0.633	0.533
BDE	2.	4.557	1.266	0.285
ABDE	2.	6.835	1.900	0.154
CDE	4.	5.696	1.583	0.183
ACDE	4.	6.835	1.900	0.114
BCDE	4.	5.696	1.583	0.183
ABCDE	4.	4.557	1.266	0.286
S-Within	132.	3.598		

Table 12. Tests on the means of the interaction between sex and grade for height (cm).

	Grade 1 (1)	Grade 3 (3)	Grade 6 (6)
Boys (B)	119.20	131.26	147.74
n	30	29	28
Girls (G)	116.10	129.66	151.17
	29	28	24

	P
H1: G1 < B1	N.S.
H2: G3 < B3	N.S.
H3: B6 < G6	N.S.

N.S. $p > .05$

Table 13. Tests on the grade means for height (cm).

Grade	Means	n
1	117.7	59
3	130.5	57
6	149.3	52

	P
H1: 1 < 3	*
H2: 3 < 6	*

* $p \leq .05$

Table 14. Summary table of the simple interaction effects for the sex (S), grade, and time (Ti) interaction for height.

Source	Mean Squares	df	Mean Squares	F
S x Ti for grade 1	2.534	1	2.534	0.70
S x Ti for grade 3	3.561	1	3.561	1.01
S x Ti for grade 6	17.769	1	17.769	4.94*
SS-Within	475.000	132	3.598	

* $p \leq .05$

Table 15. Tests on the grade six means of the sex and time interaction effect for height (cm).

	Boys (B)	Girls (G)
Pre-test (1)	146.32	148.93
Post-test (2)	149.16	153.41
n	28	24
		p
	H1: B1 < G1	*
	H2: B2 < G2	*
	H3: G1-B1 < G2-B2	**

* $p \leq .05$

** $p \leq .05$ using the Scheffe test

Table 16. Tests on the means of the interaction between treatment group and time for height (cm).

	Experimental (E)	Control (C)
Pre-test (1)	130.93	129.23
Post-test (2)	133.93	133.11
n	86	82

	p
H1: E1 < C1	*
H2: E2 < C2	*
H3: E2-E1 < C2-C1	**

* $p \leq .05$
** $p \leq .05$ using the Scheffe test

Table 17. Test on the time means for height (cm).

Time	Means	n
Pre-test	130.1	168
Post-test	133.5	168

	p
H: Pre < Post	*

* $p \leq .05$

Rable 18. Summary table of the analysis of variance using wrist circumference as the dependent variable.

(A = Treatment group, B = Sex, C = Grade, D = Initial PWC_{170}/kg level, E = Time)

Source	Degrees of Freedom	Mean Squares	F Ratio	Probability
A	1.	0.354	0.389	0.534
B	1.	21.669	23.822	0.001
AB	1.	1.061	1.167	0.282
C	2.	125.159	148.589	0.001
AC	2.	0.628	0.690	0.503
BC	2.	1.813	1.993	0.140
ABC	2.	2.795	3.073	0.050
D	2.	3.184	3.500	0.033
AD	2.	0.991	1.089	0.340
BD	2.	0.159	0.175	0.840
ABD	2.	0.478	0.525	0.593
CD	4.	1.362	1.497	0.207
ACD	4.	0.858	0.943	0.441
BCD	4.	0.261	0.287	0.886
ABCD	4.	1.052	1.157	0.333
S-Within	131.	0.910		
E	1.	1.557	35.927	0.001
AE	1.	0.230	5.307	0.023
BE	1.	0.018	0.408	0.524
ABE	1.	0.0	0.0	0.999
CE	2.	0.195	4.491	0.013
ACE	2.	0.027	0.612	0.544
BCE	2.	0.009	0.204	0.816
ABCE	2.	0.018	0.408	0.666
DE	2.	0.071	1.633	0.199
ADE	2.	0.035	0.817	0.444
BDE	2.	0.080	1.837	0.163
ABDE	2.	0.009	0.204	0.816
CDE	4.	0.031	0.714	0.583
ACDE	4.	0.022	0.510	0.728
BCDE	4.	0.013	0.306	0.873
ABCDE	4.	0.0	0.0	0.999
S-Within	131.	0.043		

Table 19. Tests on the means of the sex main effect for the wrist circumference (cm).

Sex	Means	n
Boys	13.03	87
Girls	12.47	80

	p
H: G < B	*

$* \; p \leq .05$

Table 20. Tests on the means of the grade main effect for the wrist circumference (cm).

Grade	Means	n
1	11.80	59
3	12.59	56
6	14.04	52

	p
H1: 1 < 3	*
H2: 3 < 6	*

$* \; p \leq .05$

Table 21. Tests on the means of the time main effect for wrist circumference (cm).

Time	Means	n
Pre-test	12.694	167
Post-test	12.827	167

	p
H: Pre < Post	*

* $p \leq .05$

Table 22. Tests on the means of the initial PWC_{170}/kg level main for wrist circumference (cm).

Level	Means	n
High (H)	12.62	56
Medium (M)	12.74	55
Low (L)	12.92	56

	p
H1: H < M	N.S
H2: M < L	N.S.
H3: H < L	N.S.

N.S. $p > .05$

Table 23. Tests on the means of the interaction between grade and time for wrist circumference (cm).

	Grade 1 (A)	Grade 3 (B)	Grade 6 (C)
Pre-test (1)	11.756	12.541	13.923
Post-test (2)	11.837	12.637	14.154
n	59	57	52

	p
H1: B2-B1 < C2-C1	**
H2: A2-A1 < B2-B1	N.S.

** p ≤ .05 using the Scheffe test
N.S. p > .05

Table 24. Tests on the means of the interaction between treatment group and time for the wrist circumference (cm).

	Experimental (E)	Control (C)
Pre-test (1)	12.695	12.693
Post-test (2)	12.779	12.877
n	85	82

	p
H1: C1 < E1	N.S.
H2: E2 < C2	

* p ≤ .05 N.S. p > .05

Table 25. Summary table of the analysis of variance using body weight as the dependent variable.

(A = Treatment group, B = Sex, C = Grade, D = Initial PWC_{170}/kg level, E = Time)

Source	Degrees of Freedom	Mean Squares	F Ratio	Probability
A	1.	21.112	0.366	0.546
B	1.	7.156	0.124	0.725
AB	1.	77.735	1.348	0.248
C	2.	8872.320	153.877	0.001
AC	2.	9.096	0.158	0.854
BC	2.	183.258	3.178	0.045
ABC	2.	124.471	2.159	0.120
D	2.	360.730	6.256	0.003
AD	2.	72.146	1.251	0.290
BD	2.	20.613	0.358	0.700
ABD	2.	77.317	1.341	0.265
CD	4.	122.531	2.125	0.081
ACD	4.	110.035	1.908	0.113
BCD	4.	11.268	0.195	0.940
ABCD	4.	38.027	0.660	0.621
S-Within	132.	57.659		
E	1.	228.898	207.393	0.001
AE	1.	0.819	0.742	0.391
BE	1.	2.172	0.968	0.163
ABE	1.	1.976	1.790	0.183
CE	2.	10.867	9.846	0.001
ACE	2.	0.872	0.790	0.456
BCE	2.	0.623	0.564	0.570
ABCE	2.	2.572	2.331	0.101
DE	2.	0.634	2.387	0.096
ADE	2.	0.169	0.153	0.858
BDE	2.	1.922	1.742	0.179
ABDE	2.	1.050	0.952	0.389
CDE	4.	1.032	0.935	0.446
ACDE	4.	2.550	2.310	0.061
BCDE	4.	1.175	1.064	0.377
ABCDE	4.	0.401	0.363	0.835
S-Within	132.	1.104		

Table 26. Tests on the means of the interaction between sex and grade for body weight (kg).

	Grade 1 (1)	Grade 3 (3)	Grade 6 (6)
Boys (B)	22.765	27.252	37.795
n	30	29	28
Girls (G)	20.743	26.945	41.423
n	29	28	24

	p
H1: G1 < B1	N.S.
H2: G3 < B3	N.S.
H3: B6 < G6	N.S.

N.S. $p > .05$

Table 27. Tests on the grade means for body weight (kg).

Grade	Means	n
1	21.77	59
3	27.10	57
6	39.47	52

	p
H1: G1 < G3	*
H2: G3 < G6	*

* $p \le .05$

Table 28. Tests on the initial PWC$_{170}$/kg level means for body weight (kg).

Level	Means	n
High (H)	27.50	56
Medium (M)	28.89	56
Low (L)	30.79	56

	p
H1: H < M	N.S.
H2: M < L	N.S.
H3: H < L	N.S.

N.S. $p > .05$

Table 29. Tests on the means of the interaction between grade and time for body weight (kg).

	Grade 1 (A)	Grade 3 (B)	Grade 6 (C)
Pre-test (1)	22.169	26.386	38.260
Post-test (2)	22.373	27.816	40.679
n	59	57	52

		p
H1:	A1 < A2	N.S.
H2:	B1 < B2	*
H3:	C1 < C2	*
H4:	B2-B1 < C2-C1	**
H5:	A2-A1 < B2-B1	**

* $p \leq .05$

** $p \leq .05$ using the Scheffe test

N.S. $p > .05$

Table 30. Test on the time means for body weight (kg).

Time	Means	n
Pre-test	28.23	168
Post-test	29.89	168

	P
H: Pre < Post	*

* $p \leq .05$

Table 31. Summary table of the analysis of variance using corrected upper-arm diameter as the dependent variable.

(A = Treatment group, B = Sex, C = Grade,
D = Initial PWC_{170}/kg level, E = Time

Source	Degrees of Freedom	Mean Squares	F Ratio	Probability
A	1.	14.717	0.540	0.464
B	1.	425.944	15.636	0.001
AB	1.	39.057	1.434	0.233
C	2.	3571.842	131.123	0.001
AC	2.	42.028	1.543	0.218
BC	2.	2.406	0.088	0.916
ABC	2.	117.311	4.307	0.015
D	2.	42.028	1.543	0.218
AD	2.	46.557	1.709	0.185
BD	2.	11.179	0.410	0.664
ABD	2.	30.142	1.106	0.334
CD	4.	15.142	0.556	0.695
ACD	4.	38.066	1.397	0.238
BCD	4.	11.108	0.408	0.803
ABCD	4.	25.047	0.919	0.455
S-Within	131.	27.240		
E	1.	331.981	109.150	0.001
AE	1.	0.0	0.0	0.999
BE	1.	0.0	0.0	0.999
ABE	1.	9.340	3.071	0.082
CE	2.	15.000	4.932	0.009
ACE	2.	0.142	0.047	0.955
BCE	2.	1.698	0.558	0.574
ABCE	2.	6.934	2.280	0.106
DE	2.	16.415	5.397	0.006
ADE	2.	1.132	0.372	0.690
BDE	2.	1.274	0.419	0.659
ABDE	2.	2.264	0.744	0.477
CDE	4.	5.873	1.931	0.109
ACDE	4.	1.910	0.628	0.643
BCDE	4.	1.769	0.582	0.677
ABCDE	4.	1.981	0.651	0.627
S-Within	131.	3.042		

Table 32. Tests on the sex means for corrected upper arm diameter (mm).

Sex	Means	n
Boys (B)	48.64	87
Girls (G)	46.24	80

	p
H: G < B	*

* $p \leq .05$

Table 33. Tests on the grade means for corrected upper arm diameter (mm).

Grade	Means	n
1	42.32	59
3	46.77	56
6	54.09	52

	p
H1: 1 < 3	*
H2: 3 < 6	*

* $p \leq .05$

Table 34. Tests on the means of the interaction between grade and time for corrected upper arm diameter (mm).

	Grade 1(O)	Grade 3 (T)	Grade 6 (S)
Pre-test (1)	41.54	45.98	52.58
Post-test (2)	43.10	47.55	55.59
n	59	56	52

		P
H1:	O1 < O2	*
H2:	T1 < T2	*
H3:	S1 < S2	*
H4:	T2-T1 < S2-S1	**
H5:	O2-O1 < T2-T1	N.S.

* $p \leq .05$

** $p \leq .05$ using the Scheffe test

N.S. $p > .05$

Table 35. Tests on the means of the interaction between initial PWC_{170}/kg level and time for corrected upper arm diameter (mm).

	High (H)	Medium (m)	Low (L)
Pre-test (1)	46.45	46.78	46.39
Post-test (2)	47.47	49.12	48.87
n	56	55	56

		p
H1:	$H1 < H2$	*
H2:	$M1 < M2$	*
H3:	$L1 < L2$	*
H4:	$M2-M1 < L2-L1$	N.S.
H5:	$H2-H1 < M2-M1$	**

* $p \leq .05$

** $p \leq .05$ using the Scheffe test

N.S. $p > .05$

Table 36. Test on the time means for corrected upper arm diameter (mm).

Time	Means	n
Pre-test	46.47	167
Post-test	48.48	167

	P
H: Pre < Post	*

* $p \leq .05$

Table 37. Summary table of the analysis of variance using PWC_{170}/kg as the dependent variable.

(A = Treatment group, B = Sex, C = Grade, D = Initial PWC_{170}/kg level, E = Time)

Source	Degrees of Freedom	Mean Squares	F Ratio	Probability
A	1.	0.676	0.171	0.680
B	1.	492.597	124.251	0.001
AB	1.	17.569	4.432	0.037
C	2.	10.974	2.768	0.066
AC	2.	8.170	2.061	0.131
BC	2.	38.351	9.674	0.001
ABC	2.	1.139	0.287	0.751
D	2.	383.025	96.612	0.001
AD	2.	3.249	0.819	0.443
BD	2.	8.010	2.020	0.137
ABD	2.	3.364	0.849	0.430
CD	4.	3.987	1.006	0.407
ACD	4.	1.455	0.367	0.832
BCD	4.	5.140	1.296	0.275
ABCD	4.	3.133	0.790	0.534
S-Within	132.	3.965		
E	1.	86.191	30.601	0.001
AE	1.	23.977	8.513	0.004
BE	1.	1.121	0.398	0.529
ABE	1.	0.463	0.164	0.686
CE	2.	6.631	2.354	0.099
ACE	2.	5.100	1.811	0.168
BCE	2.	20.631	7.325	0.001
ABCE	2.	2.465	0.875	0.419
DE	2.	56.909	20.205	0.001
ADE	2.	10.565	3.751	0.026
BDE	2.	2.946	1.046	0.354
ABDE	2.	1.709	0.607	0.547
CDE	4.	3.596	1.277	0.282
ACDE	4.	4.508	1.601	0.178
BCDE	4.	2.118	0.752	0.558
ABCDE	4.	2.052	0.728	0.574
ES-Within	132.	2.817		

Table 38. Tests on the means of the interaction between treatment group and sex for PWC_{170}/kg.

	Experimental (E)	Control (c)
Boys (B)	14.45	13.95
n	43	44
Girls (G)	11.57	12.05
n	43	38

	p
H1: BC < EC	N.S.
H2: GE < GC	N.S.

N.S. p > .05

Table 39. Tests on the sex means for PWC_{170}/kg.

Sex	Means	n
Boys (B)	14.19	88
Girls (G)	11.78	80

	p
H: G < B	*

* p ≤ .05

Table 40. Tests on the means of the interaction between grade and sex for PWC_{170}/kg.

	Grade 1	Grade 3	Grade 6
Boys (B)	13.75	13.82	15.04
n	30	29	28
Girls (G)	11.52	12.48	11.29
n	29	28	24

	P
H1: B1 < B3	N.S.
H2: G1 < G3	N.S.
H3: B3 < B6	*
H4: G6 < G3	*

* $p \leq .05$

N.S. $p > .05$

Table 41. Summary of the analysis of the simple interaction effects of the sex (S), grade, and time (Ti) interaction for PWC_{170}/kg.

Source	Mean Squares	df	Mean Squares	F
S x Ti for grade 1	0.32	1	0.32	0.11
S x Ti for grade 3	31.441	1	31.441	11.16*
S x Ti for grade 6	17.744	1	17.744	6.30*
SS-Within	371.789	132	2.817	

* $p \leq .05$

Table 42. Tests on the means of the simple interaction effect between sex and time for grade 3 for PWC_{170}/kg.

	Boys (B)	Girls (G)
Pre-test (1)	12.97	12.68
Post-test (2)	14.67	12.28
n	29	28

	p
H1: B1 < B2	*
H2: G2 < G1	N.S.
H3: G1 < B1	N.S.
H4: G2 < B1	*

* $p \leq .05$ N.S. $p > .05$

Table 43. Tests on the means of the simple interaction effect between sex and time for grade 6 for PWC_{170}/kg.

	Boys (B)	Girls (G)
Pre-test (1)	14.97	10.39
Post-test (2)	15.11	12.19
n	28	24
		p
	H1: B1 < B2	N.S.
	H2: G1 < G2	*

* p ≤ .05 N.S. p > .05

Table 44. Tests on the initial PWC_{170}/kg level means for PWC_{170}/kg.

Level	Means	n
High (H)	14.88	56
Medium (M)	13.12	56
Low (L)	11.09	56
		p
	H1: L < M	*
	H2: M < H	*

*p ≤ .05

Table 45. Summary table of the analysis of the simple interaction effects for each initial PWC_{170}/kg level of the treatment group (Tr) and time (T) interaction for PWC_{170}/kg.

Source	Mean Squares	df	Mean Squares	F
Tr x Ti for high	5.899	1	5.899	2.09
Tr x Ti for medium	0.007	1	0.007	0.002
Tr x Ti for low	43.825	1	43.825	15.56*
SS-Within	371.789	132	2.817	

* $p \leq .05$

Table 46. Tests on the means of the simple interaction effect for the low PWC_{170}/kg level using PWC_{170}/kg as the dependent variable.

	Experimental (E)	Control (C)
Pre-test (1)	9.24	10.56
Post-test (2)	12.87	11.69
n	28	28

		P
H1:	E1 < C1	*
H2:	C2 < E2	*
H3:	C1 < C2	N.S.
H4:	E1 < E2	*

* $p \leq .05$ N.S. $p > .05$

Table 47. Test on the time means for PWC_{170}/kg.

Time	Means	n
Pre-test	12.50	168
Post-test	13.56	168

	p
H: Pre < Post	*

* $p \leq .05$

Table 48. Summary table of the analysis of variance using the sum of skinfolds as the dependent variable.

(A = Treatment group, B = Sex, C = Grade, D = Initial PWC_{170}/kg level, E = Time)

Source	Degrees of Freedom	Mean Squares	F Ratio	Probability
A	1.	123.038	0.123	0.726
B	1.	8741.965	8.768	0.004
AB	1.	4154.813	4.167	0.043
C	2.	11302.836	11.337	0.001
AC	2.	576.313	0.578	0.562
BC	2.	1403.545	1.408	0.248
ABC	2.	394.035	0.395	0.674
D	2.	10955.086	10.988	0.001
AD	2.	88.291	0.087	0.915
BD	2.	1617.153	1.622	0.201
ABD	2.	900.855	0.904	0.408
CD	4.	1554.637	1.559	0.189
ACD	4.	172.239	0.173	0.952
BCD	4.	170.744	0.171	0.953
ABCD	4.	37.666	0.038	0.997
S-Within	132.	997.004		
E	1.	64.937	4.290	0.040
AE	1.	186.836	12.342	0.001
BE	1.	3.987	0.263	0.609
ABE	1.	10.538	0.696	0.406
CE	2.	7.263	0.480	0.620
ACE	2.	4.130	0.273	0.762
BCE	2.	17.658	1.166	0.315
ABCE	2.	0.854	0.056	0.945
DE	2.	16.234	1.072	0.345
ADE	2.	58.956	3.894	0.023
BDE	2.	4.984	0.329	0.720
ABDE	2.	8.117	0.536	0.586
CDE	4.	30.688	2.027	0.094
ACDE	4.	56.606	3.739	0.006
BCDE	4.	11.820	0.781	0.540
ABCDE	4.	1.851	0.122	0.974
ES-Within	132.	15.138		

Table 49. Tests on the means of the interaction between treatment group and sex for the sum of six skinfolds (mm).

	Experimental (E)	Control (C)
Boys (B)	36.53	45.36
n	43	44
Girls (G)	54.18	46.15
n	43	38

	p
H1: BE < BC	N.S.
H2: GC < GE	N.S.
H3: BC < GC	N.S.
H4: BE < GE	N.S.

N.S. $p > .05$

Table 50. Tests on the sex means for the sum of six skinfolds (mm).

Sex	Means	n
Boys (B)	41.00	88
Girls (G)	50.41	80

	p
H: B < G	N.S.

N.S. $p > .05$

Table 51. Tests on the grade means for the sum of six skinfolds (mm).

Grade	Means	n
1	37.44	59
3	43.28	57
6	57.20	52

		p
H1:	1 < 3	N.S.
H2:	3 < 6	N.S.
H3:	1 < 6	*

* $p \leq .05$ N.S. $p > .05$

Table 52. Tests on the initial PWC_{170}/kg level means for the sum of six skinfolds (mm).

Level	Means	n
High (H)	38.54	56
Medium (M)	41.61	56
Low (L)	56.46	56

		p
H1:	H < M	N.S.
H2:	M < L	*

* $p \leq .05$ N.S. $p > .05$

Table 53. Summary of the analysis of the simple interaction effects of the treatment group (Tr), grade (Gr), initial PWC_{170}/kg level, and time (Ti) interaction for the sum of six skinfolds.

Source	Mean Squares	df	Mean Squares	F
Tr x Gr x Ti for high	126.019	2	63.010	4.16*
Tr x Gr x Ti for medium	23.611	2	11.805	0.78
Tr x Gr x Ti for low	96.687	2	48.344	36.19*
For the high level				
Tr x Ti for grade 1	21.602	1	21.602	1.43
Tr x Ti for grade 3	52.475	1	52.475	3.47
Tr x Ti for grade 6	54.596	1	54.596	3.61
For the low level				
Tr x Ti for grade 1	100.469	1	100.469	6.64*
Tr x Ti for grade 3	5.662	1	5.662	0.37
Tr x Ti for grade 6	241.379	1	241.379	15.95*
SS-Within	1998.250	132	15.138	

* $p \leq .05$

Table 54. Tests on the means of the simple interaction effect for grade 1 low PWC_{170}/kg level interaction between treatment group and time for the sum of six skinfolds (mm).

	Experiemntal (E)	Control (C)
Pre-test (1)	44.50	42.94
Post-test (2)	39.98	44.76
n	10	10

	p
H1: C1 < E1	N.S.
H2: E2 < C2	*
H3: C1 < C2	N.S.
H4: E2 < E1	N.S.

* $p \leq .05$

N.S. $p > .05$

Table 55. Tests on the means of the simple interaction effect for grade 6 low PWC_{170}/kg level interaction between treatment group and time for the sum of six skinfolds (mm).

	Experimental (E)	Control (C)
Pre-test (1)	79.36	73.98
Post-test (2)	75.47	80.76
n	9	8

	P
H1: C1 < E1	*
H2: E2 < C2	*
H3: E2 < E1	N.S.
H4: C1 < C2	*

* p < .05 N.S. p > .05

Table 56. Test on the time means for the sum of six skinfolds (mm).

Time	Means	n
Pre-test	46.01	168
Post-test	45.06	168

	P
H: Pre < Post	N.S.

N.S. p > .05

Table 57. Summary table of the analysis of variance using flexibility as the dependent variable.

(A = Treatment group, B = Sex, C = Grade,
D = Initial PWC_{170}/kg level, E = Time)

Source	Degrees of Freedom	Mean Squares	F Ratio	Probability
A	1.	1146.201	21.212	0.001
B	1.	942.758	17.447	0.001
AB	1.	16.003	0.296	0.587
C	2.	184.245	3.410	0.036
AC	2.	48.640	0.900	0.409
BC	2.	137.011	2.536	0.083
ABC	2.	8.277	0.153	0.858
D	2.	57.630	1.067	0.347
AD	2.	0.587	0.011	0.989
BD	2.	164.611	3.046	0.051
ABD	2.	236.170	4.371	0.015
CD	4.	61.777	1.143	0.339
ACD	4.	79.520	1.472	0.214
BCD	4.	105.892	1.960	0.104
ABCD	4.	18.450	0.341	0.850
S-Within	132.	54.035		
E	1.	4.308	0.766	0.383
AE	1.	3.240	0.576	0.449
BE	1.	1.104	0.196	0.659
ABE	1.	0.071	0.013	0.911
CE	2.	11.081	1.969	0.144
ACE	2.	13.092	2.327	0.102
BCE	2.	3.970	0.705	0.496
ABCE	2.	6.355	1.129	0.326
DE	2.	2.741	0.487	0.615
ADE	2.	3.329	0.592	0.555
BDE	2.	3.035	0.539	0.584
ABDE	2.	2.020	0.359	0.699
CDE	4.	10.298	1.830	0.127
ACDE	4.	10.017	1.780	0.137
BCDE	4.	4.521	0.804	0.525
ABCDE	4.	10.489	1.864	0.120
ES-Within	132.	5.627		

Table 58. Tests on the treatment group means for the sit and reach (cm).

Treatment Group	Means	n
Experimental (E)	31.63	86
Control (C)	27.68	82

	p
H: C < E	*

* $p \leq .05$

Table 59. Tests on the sex means for the sit and reach (cm).

Sex	Means	n
Boys (B)	28.08	88
Girls (G)	31.44	80

	p
H: B < G	*

* $p \leq .05$

Table 60. Tests on the grade means for the sit and reach (cm).

Grade	Means	n
1	31.16	59
3	29.05	57
6	28.76	52

	p
H1: 3 < 1	N.S.
H2: 6 < 3	N.S.
H3: 6 < 1	N.S.

N.S. $p > .05$

Table 61. Means for height (cm) for boys from different studies, cross-sectional and longitudinal.

		6 years	8 years	11 years
McCommon (1970)	$\bar{X}$	116.2	128.8	144.2
	SD	3.53	4.28	4.84
	n	91	92	76
Backstrom et al.(1971)	$\bar{X}$	115.0	127.0	142.0
	SD	4.4	4.5	5.4
	n	200	911	824
Brundtland et al.(1975)	$\bar{X}$	-	129.7	144.7
	SD		5.5	6.3
	n		1082	1121
Karlberg et al.(1976)	$\bar{X}$	116.6	128.6	144.1
	SD	4.63	5.31	6.09
	n	117	114	110
This study (Pre-test)	$\bar{X}$	117.4	129.4	146.3
	n	30	29	28

Table 62. Means for height (cm) for girls from different studies, cross-sectional and longitudinal.

		6 years	8 years	11 years
McCommon (1970	$\bar{X}$	115.6	127.7	144.6
	SD	4.48	5.16	7.25
	n	95	90	70
Backstrom et al.(1971)	$\bar{X}$	113.7	125.0	141.0
	SD	4.5	4.5	6.2
	n	201	925	675
Brundtland et al.(1975)	$\bar{X}$	-	128.9	145.1
	SD		5.5	7.3
	n		1003	1116
Karlberg et al.(1976)	$\bar{X}$	115.6	127.4	144.3
	SD	4.66	5.47	7.01
	n	81	81	80
This study (Pre-test)	$\bar{X}$	114.5	128.2	148.9
	n	29	28	24

Table 63. Means for body weight (kg) for boys from different studies, cross-sectional and longitudinal.

		6 years	8 years	11 years
McCommon (1970)	$\bar{X}$	21.0	26.8	36.4
	SD	2.15	3.31	4.83
	n	91	92	76
Backstrom et al. (1971)	$\bar{X}$	19.6	24.9	32.5
	SD	2.3	2.9	4.3
	n	203	910	824
Brundtland et al. (1975)	$\bar{X}$	-	27.0	36.2
	SD		3.8	5.7
	n		1082	1120
Karlberg et al. (1976)	$\bar{X}$	20.8	25.8	36.3
	SD	2.77	3.92	6.72
	n	81	81	80
This study (Pre-test)	$\bar{X}$	22.2	26.7	36.7
	n	30	29	28

Table 64. Means for body weight (kg) for girls from different studies, cross-sectional and longitudinal.

		6 years	8 years	11 years
McCommon (1970)	$\bar{X}$	20.5	26.0	36.0
	SD	2.49	3.78	7.04
	n	95	90	70
Backstrom et al. (1971)	$\bar{X}$	19.2	24.0	32.6
	SD	2.0	3.1	5.6
	n	204	925	674
Brundtland et al. (1975)	$\bar{X}$	-	26.8	37.1
	SD		4.4	7.1
	n		1003	1117
Karlberg et al. (1976)	$\bar{X}$	20.8	25.8	36.3
	SD	2.77	3.92	6.72
	n	81	81	80
This study (Pre-test)	$\bar{X}$	20.1	26.1	40.1
	n	29	28	24

Table 65. Comparison between the means of two studies for corrected upper arm diameter (mm).

		Boys		
		6 years	8 years	11 years
Frisancho (1974)	15th	43	46	50
	50th	47	50	55
	85th	51	55	62
	n	264	301	294
This study (pre-test)	$\bar{X}$	42.9	46.9	53.4
	n	30	29	28

		Girls		
		6 years	8 years	11 years
Frisancho (1974)	15th	41	45	48
	50th	45	48	55
	85th	49	53	62
	n	259	270	268
This study (pre-test)	$\bar{X}$	40.1	45.1	51.6
	n	29	28	24

Table 66. Comparison between the means of different studies for PWC_{170}/kg for boys.

		Age in years					
		6	7	8	9	11	12
Howell et al. (1968)	$\bar{X}$	-	11.97	12.71	12.73	13.21	13.33
	SD		3.75	2.94	2.75	3.11	3.15
	n		95	101	119	122	101
Quinney et al. (1978)	$\bar{X}$	-	8.97	-	11.26	-	12.22
	n		-		50		50
This study (Pre-test)	$\bar{X}$	13.02	-	12.97	-	14.97	-
	n	30		29		28	
This study (Post-test)	$\bar{X}$	-	14.49	-	14.67	-	15.11
	n		30		29		28

Table 67. Comparison between the means of different studies for PWC$_{170}$/kg for girls.

		Age in years					
		6	7	8	9	11	12
Howell et al. (1968)	$\bar{X}$	-	9.61	10.67	10.27	10.08	9.92
	SD		2.59	3.75	2.50	2.78	2.60
	n		96	114	104	101	101
Quinney et al. (1978)	$\bar{X}$	-	8.40	-	9.45	-	10.13
	n		50		50		50
This study (Pre-test)	$\bar{X}$	10.68	-	12.68	-	10.39	-
	n	29		28		24	
This study (Post-test)	$\bar{X}$	-	12.35	-	12.28	-	12.19
	n		29		28		24

Table 68. Comparison between the means obtained in two different studies for the average of six skinfolds (mm).

		Boys	
		8.5-9 years	11.5-12 years
Forbes et al. (1970)	$\bar{X}$	8.6	12.0
	SD	2.9	6.4
	n	12	24
This study (Post-test)	$\bar{X}$	6.7	7.95
	n	29	28

		Girls	
		8.5-9 years	11.5-12 years
Forbes et al. (1970)	$\bar{X}$	11.0	13.0
	SD	5.7	3.4
	n	12	8
This study (Post-test)	$\bar{X}$	7.73	11.1
	n	28	24

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APPENDIX I

QUESTIONNAIRE

GENERAL PHYSICAL ACTIVITY QUESTIONNAIRE

Students Name ______________________________ Age ____ Age ____

Instructions: Please place a checkmark beside the appropriate answer or answers in each of the questions below.

1. Considering all the activities your child participates in, how would you rate him/her as to the amount of physical activity he/she gets compared to most other boys and girls of the same age?

______	______	______	______	______
Much less active	Somewhat less active	About the same	Somewhat more active	Much more active

2. In what situations does your child get most of his/her activity?

______	______	______	______	______
At school	With family	In local community	With friends	Other (please specify)

3. How many hours of television does your child watch in one week?

______	______	______	______
Less than 7 hrs 1 hour/day	8-14 hours from 1-2 hours per day	15-21 hours 2-3 hours per day	More than 21 hours. More than 3 hrs/day

4. How does your child usually travel to and from school?

______	______	______	______
Walks	Rides a bicycle	Rides in a car	Rides in a bus

5. What chores does your child do around the home on a regular basis?

______	______	______	______
Dishes	House cleaning	Lawn maintenance	Snow shovelling

Other (please specify) ______________________________

SPORTS AND LEISURE TIME PARTICIPATION EVALUATION

Instructions: This checklist should be filled out by the parents taking into account the activities the parents and child have participated in over the past year (September 1977 to Septembre 1978). In the case of the child, do not include activities that he/she participated in during physical education classes at school. Please place a checkmark in the appropriate columns indicating the activities in which the various family members have participated. Also indicate the number of hours per week and number of weeks per year (approximately) for activities in which the child participated.

ACTIVITY	Participated in by			Time Allotment for Child	
	Mother	Father	Child	Hours/week	Weeks/year
Archery					
Bowling					
Camping					
Canoeing					
Sailing					
Fishing					
Skiing (downhill)					
Softball					
Volleyball					
Golf					
Basketball					
Bicycling					
Tennis					
Football(flag)					
Hiking					
Ice Hockey					
Skating(figure)					
Skating (speed or recreation					
Tobogganning					
Skiing (cross country)					
Dance					
Soccer					
Swimming					
Gymnastics					
Track & Field					
Handball/Squash					
Badminton					
Baseball					
Football(tackle)					
Power Tobogganning					
Others					

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APPENDIX II

MEANS AND STANDARD DEVIATIONS FOR EACH SUB-GROUP FOR EACH DEPENDENT VARIABLE

Means and standard deviations of each sub-group for height (cm)

A	B	C	D	E	Mean	Std. Dev.	n
1	1	1	1	1	122.220	3.964	5
1	1	1	1	2	125.160	4.054	5
1	1	1	2	1	116.660	4.968	5
1	1	1	2	2	120.800	5.056	5
1	1	1	3	1	114.680	5.841	5
1	1	1	3	2	117.760	5.871	5
1	1	2	1	1	130.620	7.642	5
1	1	2	1	2	134.720	8.233	5
1	1	2	2	1	130.500	4.813	5
1	1	2	2	2	135.060	5.811	5
1	1	2	3	1	130.380	4.385	5
1	1	2	3	2	133.620	4.952	5
1	1	3	1	1	142.475	3.333	4
1	1	3	1	2	144.950	3.467	4
1	1	3	2	1	143.180	4.746	5
1	1	3	2	2	145.740	4.850	5
1	1	3	3	1	156.150	7.244	4
1	1	3	3	2	157.225	4.498	4
1	2	1	1	1	116.020	5.664	5
1	2	1	1	2	119.340	6.408	5
1	2	1	2	1	114.020	6.442	5
1	2	1	2	2	116.980	6.686	5
1	2	1	3	1	114.040	5.504	5
1	2	1	3	2	113.920	5.507	5
1	2	2	1	1	126.300	3.867	4
1	2	2	1	2	128.975	4.613	4
1	2	2	2	1	126.920	7.096	5
1	2	2	2	2	129.640	7.893	5
1	2	2	3	1	127.400	9.047	4
1	2	2	3	2	130,575	9.460	4
1	2	3	1	1	152.200	9.993	5
1	2	3	1	2	154.720	10.266	5
1	2	3	2	1	146.320	4.143	5
1	2	3	2	2	150.200	4.895	5
1	2	3	3	1	152.320	5.394	5
1	2	3	3	2	156.600	6.230	5

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Means and standard deviations of each subgroup for height (cm) (Cont'd.)

A	B	C	D	E	Mean	Std. Dev.	n
2	1	1	1	1	116.580	3.327	5
2	1	1	1	2	120.620	3.417	5
2	1	1	2	1	116.000	1.876	5
2	1	1	2	2	119.800	2.006	5
2	1	1	3	1	117.960	4.354	5
2	1	1	3	2	122.160	4.243	5
2	1	2	1	1	127.980	5.681	5
2	1	2	1	2	132.980	4.321	5
2	1	2	2	1	127.025	3.460	4
2	1	2	2	2	129.725	4.102	4
2	1	2	3	1	129.580	4.430	5
2	1	2	3	2	131.760	3.603	5
2	1	3	1	1	143.000	6.551	5
2	1	3	1	2	146.240	6.110	5
2	1	3	2	1	150.060	4.326	5
2	1	3	2	2	154.200	5.869	5
2	1	3	3	1	144.260	3.821	5
2	1	3	3	2	147.400	3.303	5
2	2	1	1	1	114.920	5.096	5
2	2	1	1	2	118.700	5.396	5
2	2	1	2	1	114.200	5.920	4
2	2	1	2	2	118.250	4.747	4
2	2	1	3	1	113.920	9.040	5
2	2	1	3	2	118.900	9.862	5
2	2	2	1	1	125.780	4.324	5
2	2	2	1	2	128.320	3.579	5
2	2	2	2	1	131.600	6.118	5
2	2	2	2	2	135.040	6.230	5
2	2	2	3	1	130.680	4.132	5
2	2	2	3	2	133.620	4.770	5
2	2	3	1	1	142.600	6.976	3
2	2	3	1	2	146.067	6.955	3
2	2	3	2	1	152.267	14.458	3
2	2	3	2	2	163.533	26.309	3
2	2	3	3	1	145.167	5.327	3
2	2	3	3	2	148.467	5.518	3

Means and standard deviations of each subgroup for height (cm) (Cont'd.)

A = Treatment group
 1 = experimental, 2 = control

B = Sex
 1 = boys, 2 = girls

C = Grade
 1 = grade 1, 2 = grace 3, 3 = grade 6

D = Initial PWC_{170}/kg level
 1 = high, 2 = medium, 2 = low

E = Time
 1 = pre-test, 2 = post-test

Means and standard deviations for each sub-group for wrist circumference (cm)

A	B	C	D	E	Mean	Std. Dev.	n
1	1	1	1	1	12.460	0.451	5
1	1	1	1	2	12.560	0.434	5
1	1	1	2	1	12.000	0.632	5
1	1	1	2	2	12.020	0.753	5
1	1	1	3	1	11.720	0.517	5
1	1	1	3	2	11.800	0.561	5
1	1	2	1	1	12.680	0.545	5
1	1	2	1	2	12.700	0.696	5
1	1	2	2	1	12.650	0.988	4
1	1	2	2	2	12.800	1.055	4
1	1	2	3	1	12.960	0.713	5
1	1	2	3	2	13.100	0.752	5
1	1	3	1	1	13.425	0.419	4
1	1	3	1	2	13.400	0.548	4
1	1	3	2	1	13.780	0.522	5
1	1	3	2	2	13.960	0.733	5
1	1	3	3	1	14.450	0.208	4
1	1	3	3	2	14.725	0.457	4
1	2	1	1	1	11.420	0.622	5
1	2	1	1	2	11.520	0.676	5
1	2	1	2	1	11.200	0.962	5
1	2	1	2	2	11.200	1.194	5
1	2	1	3	1	11.540	1.159	5
1	2	1	3	2	11.380	1.161	5
1	2	2	1	1	12.050	0.580	4
1	2	2	1	2	12.125	0.299	4
1	2	2	2	1	11.980	0.421	5
1	2	2	2	2	11.960	0.598	5
1	2	2	3	1	12.375	1.069	4
1	2	2	3	2	12.450	0.961	4
1	2	3	1	1	14.000	0.758	5
1	2	3	1	2	14.100	0.822	5
1	2	3	2	1	13.900	0.255	5
1	2	3	2	2	14.140	0.134	5
1	2	3	3	1	14.220	0.811	5
1	2	3	3	2	14.400	0.738	5

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Means and standard deviations for each sub-group for wrist circumference (cm) (Cont'd.)

A	B	C	D	E	Mean	Std. Dev.	n
2	1	1	1	1	12.060	0.297	5
2	1	1	1	2	12.140	0.378	5
2	1	1	2	1	12.060	0.251	5
2	1	1	2	2	12.040	0.288	5
2	1	1	3	1	12.520	0.460	5
2	1	1	3	2	12.840	0.650	5
2	1	2	1	1	12.920	0.444	5
2	1	2	1	2	12.960	0.241	5
2	1	2	2	1	12.700	0.716	4
2	1	2	2	2	12.750	0.810	5
2	1	2	3	1	12.620	0.931	5
2	1	2	3	2	12.980	1.073	5
2	1	3	1	1	13.880	0.952	5
2	1	3	1	2	14.040	0.891	5
2	1	3	2	1	14.460	0.321	5
2	1	3	2	2	14.800	0.800	5
2	1	3	3	1	14.120	0.576	5
2	1	3	3	2	14.540	0.623	5
2	2	1	1	1	11.260	0.356	5
2	2	1	1	2	11.380	0.396	5
2	2	1	2	1	11.225	0.443	4
2	2	1	2	2	11.400	0.316	4
2	2	1	3	1	11.500	0.843	5
2	2	1	3	2	11.680	0.773	5
2	2	2	1	1	12.060	0.764	5
2	2	2	1	2	12.100	0.933	5
2	2	2	2	1	12.700	0.628	5
2	2	2	2	2	12.740	0.573	5
2	2	2	3	1	12.720	0.614	5
2	2	2	3	2	12.900	0.505	5
2	2	3	1	1	12.833	0.473	3
2	2	3	1	2	13.167	0.586	3
2	2	3	2	1	13.633	1.021	3
2	2	3	2	2	14.000	0.819	3
2	2	3	3	1	13.767	0.702	3
2	2	3	3	2	14.033	0.874	3

Means and standard deviations for each subgroup for wrist circumference (cm) (Cont'd.)

A = Treatment group
    1 = experimental, 2 = control

B = Sex
    1 = boys, 2 = girls

C = Grade
    1 = grade 1, 2 = grade 3, 3 = grade 6

D = Initial PWC_{170}/kg level
    1 = high, 2 = medium, 3 = low

E = Time
    1 = pre-test, 2 = Post-test

Means and standard deviations for each sub-group for body weight (kg)

A	B	C	D	E	Mean	Std. Dev.	n
1	1	1	1	1	23.800	1.718	5
1	1	1	1	2	25.500	1.642	5
1	1	1	2	1	21.800	2.465	5
1	1	1	2	2	23.160	3.071	5
1	1	1	3	1	20.100	2.434	5
1	1	1	3	2	21.040	3.010	5
1	1	2	1	1	26.300	4.192	5
1	1	2	1	2	27.060	4.406	5
1	1	2	2	1	27.600	4.174	5
1	1	2	2	2	29.000	4.561	5
1	1	2	3	1	28.000	3.446	5
1	1	2	3	2	28.980	3.521	5
1	1	3	1	1	31.250	2.217	4
1	1	3	1	2	32.375	2.530	4
1	1	3	2	1	34.400	2.837	5
1	1	3	2	2	35.460	2.804	5
1	1	3	3	1	42.125	7.122	4
1	1	3	3	2	44.075	6.721	4
1	2	1	1	1	19.900	3.050	5
1	2	1	1	2	20.800	3.984	5
1	2	1	2	1	19.900	3.070	5
1	2	1	2	2	20.700	3.650	5
1	2	1	3	1	21.200	5.427	5
1	2	1	3	2	22.540	6.288	5
1	2	2	1	1	25.500	6.055	4
1	2	2	1	2	26.300	4.739	4
1	2	2	2	1	24.800	4.222	5
1	2	2	2	2	27.880	6.038	5
1	2	2	3	1	27.625	6.047	4
1	2	2	3	2	29.175	7.771	4
1	2	3	1	1	41.000	7.866	5
1	2	3	1	2	43.200	8.357	5
1	2	3	2	1	36.900	1.636	5
1	2	3	2	2	40.020	2.464	5
1	2	3	3	1	47.100	16.471	5
1	2	3	3	2	50.240	16.171	5

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Means and standard deviations for each subgroup for body weight (kg) (Cont'd.)

A	B	C	D	E	Mean	Std. Dev	n
2	1	1	1	1	21.800	2.080	5
2	1	1	1	2	23.020	2.525	5
2	1	1	2	1	20.700	1.037	5
2	1	1	2	2	21.820	1.205	5
2	1	1	3	1	24.800	5.507	5
2	1	1	3	2	25.640	3.978	5
2	1	2	1	1	26.200	2.564	5
2	1	2	1	2	27.440	2.635	5
2	1	2	2	1	24.375	1.931	4
2	1	2	2	2	25.000	1.472	4
2	1	2	3	1	27.000	5.523	5
2	1	2	3	2	29.040	5.498	5
2	1	3	1	1	35.000	5.745	5
2	1	3	1	2	36.880	5.390	5
2	1	3	2	1	39.400	3.831	5
2	1	3	2	2	42.920	5.334	5
2	1	3	3	1	38.000	8.039	5
2	1	3	3	2	41.380	7.975	5
2	2	1	1	1	18.600	2.043	5
2	2	1	1	2	19.780	1.465	5
2	2	1	2	1	20.375	3.065	4
2	2	1	2	2	22.050	2.894	4
2	2	1	3	1	20.900	3.715	5
2	2	1	3	2	22.280	4.304	4
2	2	2	1	1	23.600	3.029	5
2	2	2	1	2	24.720	3.159	5
2	2	2	2	1	27.600	4.436	5
2	2	2	2	2	29.220	4.930	5
2	2	2	3	1	27.700	2.490	5
2	2	2	3	2	29.380	2.838	5
2	2	3	1	1	31.333	3.215	3
2	2	3	1	2	33.467	3.656	3
2	2	3	2	1	39.833	8.977	3
2	2	3	2	2	44.233	9.264	3
2	2	3	3	1	41.167	14.286	3
2	2	3	3	2	41.967	9.799	3

Means and standard deviations for each subgroup for body weight (kg) (Cont'd.)

A = Treatment group
    1 = experimental, 2 = control

B = Sex
    1 = boys, 2 = girls

C = Grade
    1 = grade 1, 2 = grade 3, 3 = grade 6

D = Initial PWC_{170}/kg level
    1 = high, 2 = medium, 3 = low

E = Time
    1 = pre-test, 2 = post-test

Means and standard deviations for each sub-group for corrected upper-arm diameter (mm)

A	B	C	D	E	Mean	Std. Dev.	n
1	1	1	1	1	45.049	1.522	5
1	1	1	1	2	46.377	1.113	5
1	1	1	2	1	41.557	2.594	5
1	1	1	2	2	43.630	3.324	5
1	1	1	3	1	40.878	2.584	5
1	1	1	3	2	42.408	2.162	5
1	1	2	1	1	45.564	4.421	5
1	1	2	1	2	45.873	4.040	5
1	1	2	2	1	47.141	3.998	4
1	1	2	2	2	48.546	6.215	4
1	1	2	3	1	48.185	3.104	5
1	1	2	3	2	49.166	4.727	5
1	1	3	1	1	51.606	2.779	4
1	1	3	1	2	52.490	3.447	4
1	1	3	2	1	52.794	3.314	5
1	1	3	2	2	56.144	3.687	5
1	1	3	3	1	53.169	2.692	4
1	1	3	3	2	56.861	4.856	4
1	2	1	1	1	40.200	2.546	5
1	2	1	1	2	41.706	3.755	5
1	2	1	2	1	39.577	4.198	5
1	2	1	2	2	41.428	4.300	5
1	2	1	3	1	38.997	3.388	5
1	2	1	3	2	40.307	5.283	5
1	2	2	1	1	43.629	2.244	4
1	2	2	1	2	45.395	3.341	4
1	2	2	2	1	43.194	2.648	5
1	2	2	2	2	44.702	3.062	5
1	2	2	3	1	44.395	3.071	4
1	2	2	3	2	47.810	5.703	4
1	2	3	1	1	53.887	4.851	5
1	2	3	1	2	56.264	6.653	5
1	2	3	2	1	51.654	2.258	5
1	2	3	2	2	55.763	2.239	5
1	2	3	3	1	53.183	2.793	5
1	2	3	3	2	56.653	5.319	5

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Means and standard deviations for each subgroup for corrected upper-arm diameter (mm) (Cont'd.)

A	B	C	D	E	Mean	Std. Dev.	n
2	1	1	1	1	41.957	2.122	5
2	1	1	1	2	43.552	3.252	5
2	1	1	2	1	42.957	2.800	5
2	1	1	2	2	43.421	2.338	5
2	1	1	3	1	45.155	4.438	5
2	1	1	3	2	46.219	3.803	5
2	1	2	1	1	47.750	1.594	5
2	1	2	1	2	49.067	1.733	5
2	1	2	2	1	48.023	5.144	4
2	1	2	2	2	51.281	8.437	4
2	1	2	3	1	45.108	4.384	5
2	1	2	3	2	47.451	5.515	5
2	1	3	1	1	54.285	4.775	5
2	1	3	1	2	56.492	5.686	5
2	1	3	2	1	55.390	1.977	5
2	1	3	2	2	59.859	5.868	5
2	1	3	3	1	52.643	2.921	5
2	1	3	3	2	56.956	3.290	5
2	2	1	1	1	39.638	1.525	5
2	2	1	1	2	40.473	0.903	5
2	2	1	2	1	42.098	2.551	4
2	2	1	2	2	43.731	4.005	4
2	2	1	3	1	40.579	3.419	5
2	2	1	3	2	44.053	5.303	5
2	2	2	1	1	44.958	2.909	5
2	2	2	1	2	46.124	4.018	5
2	2	2	2	1	47.086	2.684	5
2	2	2	2	2	47.792	2.691	5
2	2	2	3	1	46.605	2.178	5
2	2	2	3	2	47.932	3.053	5
2	2	3	1	1	47.466	4.001	3
2	2	3	1	2	45.696	5.953	3
2	2	3	2	1	50.844	4.469	3
2	2	3	2	2	54.503	3.922	3
2	2	3	3	1	50.325	6.983	3
2	2	3	3	2	54.057	8.338	3

Means and standard deviations for each sub-group for corrected upper-arm diameter (mm) (Cont'd.)

A = Treatment group
    1 = experimental, 2 = control

B = Sex
    1 = boys, 2 = girls

C = Grade
    1 = grade 1, 2 = grade 3, 3 = grade 6

D = Initial PWC_{170}/kg level
    1 = high, 2 = medium, 3 = low

E = Time
    1 = pre-test, 2 = post-test

Means and standard deviations for each sub-group for PWC_{170}/kg (kpm/min)

A	B	C	D	E	Mean	Std. Dev.	n
1	1	1	1	1	16.784	1.053	5
1	1	1	1	2	17.414	3.577	5
1	1	1	2	1	13.244	0.689	5
1	1	1	2	2	13.601	0.994	5
1	1	1	3	1	10.173	1.707	5
1	1	1	3	2	14.496	0.856	5
1	1	2	1	1	15.764	0.770	5
1	1	2	1	2	15.532	1.723	5
1	1	2	2	1	12.940	1.101	5
1	1	2	2	2	14.907	2.852	5
1	1	2	3	1	9.227	1.354	5
1	1	2	3	2	14.035	4.024	5
1	1	3	1	1	18.423	0.912	4
1	1	3	1	2	18.183	2.044	4
1	1	3	2	1	15.100	1.033	5
1	1	3	2	2	14.955	2.424	5
1	1	3	3	1	11.656	2.116	4
1	1	3	3	2	14.670	2.300	4
1	2	1	1	1	12.496	0.728	5
1	2	1	1	2	13.046	2.323	5
1	2	1	2	1	10.716	0.194	5
1	2	1	2	2	13.156	1.849	5
1	2	1	3	1	8.409	1.601	5
1	2	1	3	2	11.731	2.239	5
1	2	2	1	1	15.562	2.568	4
1	2	2	1	2	11.131	1.125	4
1	2	2	2	1	11.885	0.711	5
1	2	2	2	2	12.278	3.486	5
1	2	2	3	1	9.406	0.368	4
1	2	2	3	2	12.229	3.153	4
1	2	3	1	1	11.621	0.497	5
1	2	3	1	2	14.705	0.857	5
1	2	3	2	1	10.285	0.861	5
1	2	3	2	2	12.598	2.750	5
1	2	3	3	1	7.098	1.276	5
1	2	3	3	2	10.307	3.011	5

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Means and standard deviations for each subgroup for PWC_{170}/kg (kpm/min) (Cont'd.)

A	B	C	D	E	Mean	Std. Dev.	n
2	1	1	1	1	15.998	2.213	5
2	1	1	1	2	14.792	2.163	5
2	1	1	2	1	12.026	0.720	5
2	1	1	2	2	13.971	1.135	5
2	1	1	3	1	9.878	1.039	5
2	1	1	3	2	12.634	0.622	5
2	1	2	1	1	14.872	0.762	5
2	1	2	1	2	14.611	1.669	5
2	1	2	2	1	13.468	0.368	4
2	1	2	2	2	16.096	2.314	4
2	1	2	3	1	11.636	1.279	5
2	1	2	3	2	13.121	2.152	5
2	1	3	1	1	17.830	3.129	5
2	1	3	1	2	16.212	2.532	5
2	1	3	2	1	14.989	0.359	5
2	1	3	2	2	14.659	1.496	5
2	1	3	3	1	11.825	2.267	5
2	1	3	3	2	12.516	2.543	5
2	2	1	1	1	13.034	0.580	5
2	2	1	1	2	13.663	3.207	5
2	2	1	2	1	10.553	0.761	4
2	2	1	2	2	1[illegible]08	3.542	4
2	2	1	3	1	8.864	0.481	5
2	2	1	3	2	9.569	1.738	5
2	2	2	1	1	15.348	0.972	5
2	2	2	1	2	13.810	1.673	5
2	2	2	2	1	12.526	0.543	5
2	2	2	2	2	12.821	1.695	5
2	2	2	3	1	11.274	0.488	5
2	2	2	3	2	11.174	1.306	5
2	2	3	1	1	13.251	0.284	3
2	2	3	1	2	11.834	0.822	3
2	2	3	2	1	12.051	0.489	3
2	2	3	2	2	12.242	1.319	3
2	2	3	3	1	9.463	2.004	3
2	2	3	3	2	10.769	0.494	3

Means and standard deviations for each subgroup for PWC_{170}/kg (kpm/min) (Cont'd.)

A = Treatment group
1 = experimental, 2 = control

B = Sex
1 = boys, 2 = girls

C = Grade
1 = grade 1, 2 = grade 3, 3 = grade 6

D = Initial PWC_{170}/kg level
1 = high, 2 = medium, 2 = low

E = Time
1 = pre-test, 2 = post-test

Means and standard deviations for each sub-group for the sum of skinfolds (mm)

A	B	C	D	E	Mean	Std. Dev.	n
1	1	1	1	1	33.100	4.031	5
1	1	1	1	2	31.400	4.070	5
1	1	1	2	1	33.200	5.494	5
1	1	1	2	2	31.940	6.373	5
1	1	1	3	1	33.080	6.715	5
1	1	1	3	2	29.280	4.268	5
1	1	2	1	1	38.540	7.746	5
1	1	2	1	2	36.500	7.433	5
1	1	2	2	1	38.860	15.337	5
1	1	2	2	2	40.700	21.970	5
1	1	2	3	1	38.180	8.142	5
1	1	2	3	2	38.020	8.933	5
1	1	3	1	1	32.125	3.825	4
1	1	3	1	2	32.600	5.268	4
1	1	3	2	1	38.620	9.850	5
1	1	3	2	2	34.660	7.536	5
1	1	3	3	1	53.175	41.657	4
1	1	3	3	2	47.425	34.238	4
1	2	1	1	1	32.180	5.125	5
1	2	1	1	2	29.180	6.282	5
1	2	1	2	1	39.280	7.495	5
1	2	1	2	2	37.460	6.921	5
1	2	1	3	1	55.920	28.601	5
1	2	1	3	2	50.680	27.184	5
1	2	2	1	1	48.075	39.506	4
1	2	2	1	2	42.625	25.633	4
1	2	2	2	1	48.320	26.650	5
1	2	2	2	2	47.940	26.570	5
1	2	2	3	1	64.225	29.732	4
1	2	2	3	2	62.250	29.985	4
1	2	3	1	1	51.420	12.071	5
1	2	3	1	2	52.640	11.822	5
1	2	3	2	1	61.360	28.448	5
1	2	3	2	2	53.580	17.412	5
1	2	3	3	1	100.300	68.885	5
1	2	3	3	2	97.900	70.875	5

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Means and standard deviations for each subgroup for the sum of skinfolds (mm) (Cont'd.)

A	B	C	D	E	Mean	Std. Dev.	n
2	1	1	1	1	36.620	9.991	5
2	1	1	1	2	37.100	13.535	5
2	1	1	2	1	33.980	3.909	5
2	1	1	2	2	31.980	4.438	5
2	1	1	3	1	43.500	14.351	5
2	1	1	3	2	46.480	21.186	5
2	1	2	1	1	35.080	8.864	5
2	1	2	1	2	35.600	7.064	5
2	1	2	2	1	52.225	1.500	4
2	1	2	2	2	34.200	2.495	4
2	1	2	3	1	51.980	30.048	5
2	1	2	3	2	54.180	26.482	5
2	1	3	1	1	51.360	14.683	5
2	1	3	1	2	45.360	8.850	5
2	1	3	2	1	50.000	20.381	5
2	1	3	2	2	48.500	18.616	5
2	1	3	3	1	68.860	51.045	5
2	1	3	3	2	74.560	50.241	5
2	2	1	1	1	34.320	5.448	5
2	2	1	1	2	35.020	4.661	5
2	2	1	2	1	38.700	10.737	4
2	2	1	2	2	39.375	10.274	4
2	2	1	3	1	42.380	4.672	5
2	2	1	3	2	43.040	7.834	5
2	2	2	1	1	34.340	5.094	5
2	2	2	1	2	36.120	5.995	5
2	2	2	2	1	37.940	10.470	5
2	2	2	2	2	37.040	10.490	5
2	2	2	3	1	55.740	15.194	5
2	2	2	3	2	54.700	14.182	5
2	2	3	1	1	44.733	3.573	3
2	2	3	1	2	43.567	3.512	3
2	2	3	1	1	60.600	5.909	3
2	2	3	2	2	58.067	5.992	3
2	2	3	3	1	82.500	54.663	3
2	2	3	3	1	91.100	47.457	3

Means and standard deviations for each subgroup for the sum of skinfolds (mm) (Cont'd.)

A = Treatment group
    1 = experimental, 2 = control

B = Sex
    1 = boys, 2 = girls

C = Grade
    1 = grade 1, 2 = grade 3, 3 = grade 6

D = Initial PWC_{170}/kg level
    1 = high, 2 = medium, 3 = low

E = Time
    1 = pre-test, 2 = post-test

Means and standard deviations for each sub-group for flexibility (cm)

A	B	C	D	E	Mean	Std. Dev.	n
1	1	1	1	1	28.060	3.439	5
1	1	1	1	2	29.900	2.724	5
1	1	1	2	1	34.560	4.212	5
1	1	1	2	2	33.840	5.419	5
1	1	1	3	1	30.920	3.831	5
1	1	1	3	2	30.800	2.763	5
1	1	2	1	1	30.480	3.310	5
1	1	2	1	2	27.240	4.206	5
1	1	2	2	1	30.820	4.638	5
1	1	2	2	2	28.340	6.670	5
1	1	2	3	1	31,180	5.021	5
1	1	2	3	2	33.260	6.219	5
1	1	3	1	1	26.525	4.666	4
1	1	3	1	2	25.625	3.048	4
1	1	3	2	1	30.700	3.169	5
1	1	3	2	2	32.420	4.922	5
1	1	3	3	1	27.850	7.101	4
1	1	3	3	2	29.125	3.738	4
1	2	1	1	1	32.940	4.101	5
1	2	1	1	2	32.580	4.143	5
1	2	1	2	1	32.660	4.364	5
1	2	1	2	2	32.180	2.489	5
1	2	1	3	1	34.080	4.762	5
1	2	1	3	2	35.080	4.508	5
1	2	2	1	1	31.325	4.930	4
1	2	2	1	2	33.225	5.780	4
1	2	2	2	1	30.120	4.954	5
1	2	2	2	2	29.820	4.572	5
1	2	2	3	1	34.650	5.119	4
1	2	2	3	2	33.975	4.026	4
1	2	3	1	1	37.200	5.839	5
1	2	3	1	2	37.840	5.152	5
1	2	3	2	1	30.420	5.027	5
1	2	3	2	2	29.480	5.820	5
1	2	3	3	1	33.420	5.472	5
1	2	3	3	2	33.427	5.625	5

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Means and standard deviations for each subgroup for flexibility (cm) (Cont'd.)

A	B	C	D	E	Mean	Std. Dev.	n
2	1	1	1	1	26.260	2.418	5
2	1	1	1	2	24.360	4.930	5
2	1	1	2	1	29.900	4.966	5
2	1	1	2	2	29.960	4.180	5
2	1	1	3	1	32.660	6.882	5
2	1	1	3	2	28.880	2.874	5
2	1	2	1	1	26.620	5.875	5
2	1	2	1	2	28.420	4.359	5
2	1	2	2	1	22.200	8.165	4
2	1	2	2	2	22.525	8.701	4
2	1	2	3	1	27.860	2.548	5
2	1	2	3	2	28.860	4.223	5
2	1	3	1	1	19.240	4.191	5
2	1	3	1	2	21.140	3.810	5
2	1	3	2	1	20.640	8.258	5
2	1	3	2	2	20.440	10.415	5
2	1	3	3	1	26.540	5.285	5
2	1	3	3	2	29.900	3.385	5
2	2	1	1	1	30.120	5.263	5
2	2	1	1	2	32.260	5.781	5
2	2	1	2	1	32.450	4.740	4
2	2	1	2	2	32.925	5 058	4
2	2	1	3	1	32.060	4.387	5
2	2	1	3	2	29.080	5.306	5
2	2	2	1	1	27.280	4.692	5
2	2	2	1	2	28.720	7.202	5
2	2	2	2	1	31.880	6.147	5
2	2	2	2	2	32.660	6.949	5
2	2	2	3	1	23.200	6.952	5
2	2	2	3	2	23.180	6.781	5
2	2	3	1	1	32.367	3.208	3
2	2	3	1	2	31.700	6.154	3
2	2	3	2	1	26.433	12.123	3
2	2	3	2	2	26.567	11.927	3
2	2	3	3	1	29.333	8.221	3
2	2	3	3	2	33.167	10.027	3

Means and standard deviations for each sub-
grou for flexibility (cm) (Cont'd.)

A = Treatment group
    1 = experimental, 2 = control

B = Sex
    1 = boys, 2 = girls

C = Grade
    1 = grade 1, 2 = grade 3, 3 = grade 6

D = Initial PWC_{170}/kg level
    1 = high, 2 = medium, 3 = low

E = Time
    1 = pre-test, 2 = post-test